OPTIMAL FIVE-YEAR PLANNING USING MIXED-INTEGER LINEAR PROGRAMMING THREE MODELS IMPLEMENTED FOR NAVAL AIR TEST CENTER.

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THESIS

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MIXED INTEGER LINEAR PROGRAMMING
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NAVAL AIR TEST CENTER

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Optimal Five-Year Planning Using Mixed-Integer Linear Programming Three Models Implemented for Naval Air Test Center

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I. INTRODUCTION

A. PRESENTATION OF THE PROBLEM

An important category of problems faced within the public -- civilian and military -- and private sector organizations, consists of finding the 'best' way of using limited available resources.

In allocating resources, the 'best' solution is the solution which yields an optimal value of the most desirous return to the organization. This return, when mathematical programming is used in the process of allocating the resources, is measured by the value of the so-called Objective Function.

Objective Function is the payoff function which depends on the resources expended and/or on the output produced.

The availability and the technological use of the resources are stated and act as the constraints of the problem of achieving the optimal value of the Objective Function by maximizing or minimizing it. Because of the interaction between almost all of the resources in the environment of a large organization, the best way to approach the problem of planning the future workload is to consider all, or at least the most important, of the resources and the relationships between them.

Finding the 'best' or even a good allocation of the resources is not an easy task. Especially for large organizations, as the military, where myriad numbers of alternative

solutions exist and all of them under the conventional decision making have to be considered and evaluated before deciding which of them is the best. In these cases the problem is so large and complex that it becomes impossible to solve feasibly or optimally without using Operations Research techniques and the abilities of the computer.

The mismanagement of the available resources has today, and will have more in the future, serious impact on every aspect of the operation and the effectiveness of the organization. This is more true for the military organizations where many of the resources are high-technology and expensive systems, like aircraft, and where the planning problem includes in its possible output the procurement of very expensive items, like ships, aircraft or other weapon systems.

This fact forces the military hierarchy to seek improvement of the conventional planning process and is the motive for the development of Mathematical Programming Models and the implementation of computer-aided planning processes.

B. OBJECTIVES OF THE THESIS

This thesis was intended to investigate the application of Integer and Mixed-Integer Linear Programming Models in the process of seeking optimal medium-range planning.

The effort was concentrated to address specifically the planning problem of those organizations for which the work tasks are, or can be, organized in 'projects'. The term

'project' here means the workload unit which can be considered separately from the others in the sense that it needs its own labor and other kinds of assets in order to be accomplished; also, management must be able to measure the organization's return from accomplishing this unit of workload. Projects need not be mutually independent. Some of them might be independent, others mutually exclusive, and some might be prerequisites for others.

When this type of workoad organization is considered, then the term 'project selection' can be used for the process of determining the workload to be included in the organization's plans.

Three large-scale 'project selection' models have been developed, implemented and tested using real data from the Naval-Air-Test-Center (NATC). Thus, in parallel with the general academic objective described above, the study had as its direct target the solution of a prototype NATC budget model of current interest. This specific objective was to reach an optimal solution of the NATC planning problem and to provide the management of NATC with a computerized system, ready to be used to optimize, or substantially aid in the planning process.

The three implemented models represent a three-step attack method chosen in this work. This method -- from the simpler to the more complex -- facilitated the effort because the experience from each previous step was used in the next and also made the steps less dramatic by giving

bases for comparisons and control. Nevertheless the implementation was designed to keep each system-model independent from the others. This objective was set in order to make the comparisons between the solutions valid and also to provide the user alternate planning systems, so he can see the differences and make his policy decisions.

II. DISCUSSION

A. ALLOCATION OF RESOURCES

1. General

The ability of any organization to develop a good planning process which leads to the best possible utilization of all available assets and the determination to implement the plans are the best criteria to use if one wants to grade the organization's operation and its effectiveness.

Workforce planning is the planning of the kinds and numbers of workers needed to perform the organization's work [5].

It has been mentioned previously that this study addresses the planning problem of organizations with workloads which can be expressed in terms of projects. In these cases, workload planning is the selection of projects to be included in the organization's plans. Thus workforce and wordload planning are two sides of the same problem.

If one knows the workload plans then he can calculate the workforce needed to accomplish these plans. The inverse is not true. The reason for this is that management has the choice of using the same workforce in different project selections. So, the only way to solve the resource allocation problem, and to get a unique solution, is to find the 'best' selection of projects to be accomplished.

Some of the very important characteristics of an overall optimal planning process are the following. First, the process must be easy in its implementation. It should require less effort than the current process does, otherwise its acceptance by the management is in doubt. Second, the new process must lend itself to the existing organization's hierarchy and should be implemented with the active participation of this hierarchy. If the hierarchy is not involved, the process will soon fail. Third, the process must be flexible and leave room for the management to make decisions on policy problems and on side effects which cannot be succinctly or adequately expressed in a mathematical model.

Especially for the large scale planning models one can say that a successful implementation requires the existence of an adversary relationship between the analyst who designs the model and those managers who have a perspective of the current system. After a consensus of the model is achieved, the new planning process will be supported by the managers and the new analysis will be useful.

Any new successfully implemented system should be maintained and improved in light of the everyday reality and the changing situations. Managers should not forget that computers do not replace judgment [1].

2. Decision Making Strategies as Approaches to the Resource Allocation Problem

The intention here is not to give an extensive and complete description of the strategies used to solve the

problem of resource allocation. It is rather to concentrate on the most common of them and have a quick and critical view on each of them.

a. <u>'Disjointed Incrementalism'</u> is a decision making approach frequently used in the past and still in use today. In this approach the decision maker adjusts the status quo toward some of the goals of the organization [2]. When considering workforce planning in terms of selecting a set of projects that maximizes some measure of benefit, the incremental approach seldom achieves the best possible solution.

When the number of factors to be considered in the decision exceeds the capabilities of the decision maker, then, except for small adjustments in workforce to accomplish certain projects with apparently large benefits, there is no practical way to manually identify the projects which will maximize the total benefit.

Reference 3 gives the following main characteristics of the incremental approach in decision making. First, the decision maker focuses only on those policy alternatives which differ incrementally from the existing policy and does not attempt to evaluate all the alternatives. Only a small number of alternatives are considered. Second, for each alternative, only a restricted number of 'important' consequences are evaluated. Third, there is not a unique 'right' solution but a series of 'attacks' on the issues at hand. And the conclusion in Ref. 3 is: "As such, incremental decision making is described as remedial, geared

more to the alleviation of present concrete social imperfections than to the promotion of future social goals."

b. <u>The 'Optimum Solution' or 'Rational, Economic Man'</u> approach is the decision making strategy which, when carried through to a conclusion, results in the optimum decision. This method requires that all major factors affecting the decision are known and can be measured. Following this approach the decision-maker has to examine all possible alternatives, evaluate the 'total benefit' of each of them and compare them.

During this process he also has to keep track of the effect of each parameter on all the others. For complex problems, like the allocation of resources in large organizations, this process is impossible to be carried through without applying Operations Research methods and without using the computer.

For this kind of problem, and under the 'Rational, Economic Man' approach, Mathematical Programming is the Operations Research method which can be applied to identify the 'best' decision quickly and economically. This does not mean that in applied operations research work the analyst even pretends to be able to find the truly best of all possible decisions. The available data are often inaccurate and the analysis tools are sometimes too blunt to be able to come up with anything more than approximations to the true optimum. Nevertheless, with an analysis which is specifically designed to look for optimal decisions, even

crude and approximate solutions are likely to be much better than the workable but relatively arbitrary rules of thumb of obscure origin which play so prominent a part in practice. The contribution from the Operations Research approach stems primarily from,

(1) The structuring of the real problem into a mathematical model -- by using only the essential elements -- which leads to a solution relevant to the decision maker's objectives by looking at the problem in the context of the entire system.

(2) Exploring the structure of such solutions and developing systematic algorithms for obtaining them.

(3) Developing a solution that yields an optimal value of the system measure of desirability or comparing alternate solutions by evaluating their measure of desirability [4].

c. "Mixed Scanning" is the approach which can be considered as a combination of the optimum solution approach with the incremental approach. When significant strategy decisions have to be made, searching for all possible alternatives and seeking an optimal solution is the most suitable approach. But when no immediate threat is involved in the decision, a compromise among management can most likely be reached, using the incremental approach, rather than looking for the results of a satisficing analytical technique [3].

Sometimes the effect on the solution of factors which cannot be measured -- and are thus not included in the mathematical model of the analytical technique -- is so serious, that it makes the solution unacceptable. This possibility makes necessary the critique of the results of any analytical method and the active participation of the management in many steps of the planning process. However, subjective analysis has to be done only on those factors which have not been considered by the model. Otherwise, management does not utilize the advantages of the analytical technique and the computer in areas where the abilities of a man or even of a large group are terribly inferior.

B. RESOURCE ALLOCATION FOR NAVAL-AIR-TEST-CENTER (NATC)

1. Definitions

Reference 6 gives the following definitions of the terms PLANNING, PROGRAMMING and BUDGETING.

a. PLANNING - Determining objectives and specifying future actions to accomplish mission requirements.

Time period: Near term - Budget year + 5 years

Far term - 20 years

b. PROGRAMMING - Translating future objectives and required actions into manpower and material resource requirements.

Time period: Budget year + 1 year

c. BUDGETING - Translating approved manpower and material resource requirements into time-phased financial requirements.
Time period: One year

2. Present Method

Reference 2 has been for this thesis the basic source of information concerning the current NATC resource allocation process as well as the workforce available at NATC, which have been used in the implementation of the planning models.

NATC is typical of many large public service organizations. The planning process at NATC seems to follow the incremental approach.

For the purpose of workload planning, the workforce at NATC has been divided into twenty Functional Areas (FA). Each of the first four of them - (2A,2A,2C,2D) - includes five Cost Centers (CC) and each of the rest includes one Cost Center. So, FACC (Function Area/Cost Center) can be considered as the basic functioning workforce unit at NATC, and there are thirty six of these units [6].

Personnel ceiling levels for the NATC are determined at NAVAL AIR SYSTEMS COMMAND headquarters level, by the Assistant Commander for Test and Evaluation (AIR-06).

Workload is assigned to NATC by the Assistant Commander for Material Acquisition, (AIR-05), by the Assistant Commander for Logistics and Fleet Support, (AIR-04),

by the Assistant Commander for Research and Technology, (AIR-03), by the Navy Laboratories and other DOD and federal agencies. Workload is monitored by AIR-06 as a part of his strategic planning process, but the *selection* of projects to be accomplished is left to the NATC.

Within NATC, personnel ceiling levels are assigned to each of the directorates by the Commander of NATC, who also designates the prime FACC for each project. FACC makes the recommendation to accept or reject the project. To do that, FACC considers the available personnel, costs versus funding and the project benefit.

The real benefit of each project must be some indicator of the support which the project provides to Naval Aviation and the Fleet. As a public sector organization, profit or retained income from projects is not a good measure of the real benefit.

At NATC the project benefit is expressed in terms of a priority number assigned to the project. Historically, project priority listing has been established by a combination of benefit to Naval Aviation and the competition of resources among the projects.

The priority is the management's attempt to establish a relationship between the projects. The process of assigning or changing the priority number of a project involves the project engineer or officer, the directorate management hierarchy, and the NATC hierarchy. The Project Priority Committee at NATC discusses the relative project

priorities in terms of the relative benefits to Naval Aviation, the asset shortages and the time constraints. Each month, a listing with the priorities which have been established at first or changed is endorsed by the NATC Commander.

As reductions in civilian manpower authorizations have continued and the assigned workload has increased in the past several years, closer project priority liaison was established between NATC Commander, NATC directorates and NAVAIR in order to have increased efficiency.

Thus the 'Project Priority List' is currently a short-term dynamic, although subjective, evaluation of the relative project ranking, based on relative benefit, as the Project Priority Committee and the NATC hierarchy can measure it.

This system seems to work well in the short-range competition for resources but it is not a long -- or medium -- range selection process, since it is based only on the needs for the next year.

The Budget Council actually provides the workload plan on a year-to-year incremental basis. The method used is an effort to follow the 'zero-base' budget approach but an explicit plan is not evident and no one can say that the best possible solution to manpower and money distribution problem can be found.

It is noted that many of the projects require for their accomplishment Improvement and Modernization Projects (IMP). These IMP's improve the efficiency of test and

evaluation at NATC and require large capital investment in laboratories and equipment. Each project may have up to four IMP's as prerequisites. Before one project can be included in the plan all the related IMP's have to be funded. The IMP budget which is available each year is limited and this makes the project selection process more complex. The idea of constructing an optimum 'zero-base' budget for the IMP's has been embedded in the new planning process developed through the models implemented during this thesis work.

The term 'zero-base' budgeting introduced here means the budgeting process which leads to the optimum distribution of the total available money beginning from the point that no commitment has been made previously for any kind of funding to specific projects or organizational departments. The only criterion used for the funding of any project is the maximization of the organization's return.

Minimum, present, and optimum levels of staffing by all Function Areas are budgeted in a series of decision packages that the directorate/department management then serializes in order of decreasing priority. The priority given to a function is not specifically tied to the relative priority of the projects to be performed by this function during the next year.

Plans and Programs Office of NATC has developed in 1977 the NATC Workload Plan Management System (NATCWPMS) which is a computer file containing all project workload

for a period of eight years. This file was developed in order to provide data required by AIR-06 -- for constructing his Field Activity Plan (FAP) -- and also to provide NATC management with suitable information for justification for required resources.

For each project, it includes workload data for the immediate past and the current fiscal year, budget data for the first year beyond the current, programming data for the second year beyond the current, and planning data for the third through sixth years beyond the current fiscal year. The file is updated at six month intervals. For the implementation of the planning models, a copy of this file has been used -- called the MASTER FILE henceforth -- taken in May 1978. The MASTER FILE at that time consisted of 865 Records, each Record had a length of 2504 characters -- subsequently, the Record size has been expanded to 3005 characters -- and each Record represents a uniquely identified project at NATC. The form of the Record is given in the next page.

Since adding priorities -- to have a total picture of the solution -- is meaningless, the project priority can be transformed to another characteristic, which may include the priority factor and also other factors such as the reliability of the planning data given in the Master File. The term BENEFIT is used in Ref. 2 for the result of this transformation. A complete description of the

WORKLOAD PLANNING DATA

SUBMITTED BY COST CENTER ________

1

1 RECORD ID
2 UPDATE CODE
3 SHORT TITLE
4 AIR TASK
5 WU
6 JO
7 APPN
8 PE SUBHEAD
9 PROJ CAN NO
10 PROJ OFF ENGR
11 PRIME SUB CC
12 SPONSOR
13 PROG MGR CODE
14 COG ENGR CODE
15 A N O
16 C N
17 PSD
18 PCD

JULIAN Y Y D D D

2

19 FUNCTIONS MANYEARS			CIVILIAN: FY / tenths (8 columns)	MILITARY: FY / tenths (8 columns)	CONTRACTOR: FY / tenths (8 columns)
A VEH	2	A			
M SYS	2	B			
R & M	2	C			
A MAIN	2	D			
SUBSYSTEM	2	E			
E & E	2	F			
G.E	2	G			
OPD	2	H			
CREW SYS	2	I			
EW	2	J			
CV SUIT	2	K			
CNI	2	L			
A B INST	2	M			
RANGE	2	N			
TELCM	2	O			
COMPUTER	2	P			
INST LAB SERV	2	Q			
TID	2	R			
BASE SUP	2	S			

3

	FY	FY	FY	FY	FY	FY	FY	FY
21 TYPE A								
22 TYPE A								
23 TYPE								
24 TYPE A								

24 RELATED IMP NO

25 COST ($000)		FY tenths	FY tenths	FY tenths	FY tenths	FY tenths	FY tenths	FY tenths	FY tenths
LABOR	A								
A C	B								
INSTR	C								
MATL	D								
TRAVEL	E								
PROC	F								
CONT	G								
OTHER	H								

4

26 PASS TO OTHERS — ACTIVITY — FOR PERS

WORKLOAD PLANNING DATA FORM
NAVAIRTESTCEN 5230 106 (5/77)

transformation used in the three models is given in the paragraph II.B.4.a of this thesis, as it was proposed by Ref. 2.

Given the NATC Project Priority List, the year-end civilian and military manpower ceilings, and the MASTER FILE with the project demands, the projects to be done are taken in priority order until the labor demand equals the labor availability. It is intuitively clear that using the sequential priority order as the only criterion in selecting the projects does not necessarily lead to an optimal selection. The relative demand on resources of each project has to be used as the second criterion in the selection process. The following simple EXAMPLE is enough to convince a non-expert in Operations Research methods of the necessity of introducing the relative assets demand criterion in the selection process, together with the relative priority criterion.

Assume, for the example, that a selected project gives Benefit 0.99 (on the scale 0.0 to 1.0) but requires a large amount of assets -- such as money, military and civilian personnel -- so that if this project is excluded from the solution the organization can alternatively accomplish, using the same amount of assets, two other projects, the first with Benefit 0.80 and the second with 0.70 or even more.

It is apparent that the second alternative adds a total Benefit of 1.50 to our solution instead of 0.99

which corresponds to the first alternative. This indicates a much better solution with the second alternative. Alternatives like this are numerous, if not countless in a complex and large selection problem and thus one expects a great improvement in the solution by introducing systematically the relative assets demand as a criterion in the selection process. This is exactly what an estimization model does.

Returning to the current selection process at NATC, the following remarks can be made.

Based on the same data, Directorates/Departments of NATC establish their own Functional Priorities. Since a specific way to establish these functional priorities according to the project priorities does not exist, it is possible to have conflict between the Project Priority List and the functional priorities submitted to the Budget Council by the Directorates/Departments. The Budget Council makes an effort to establish a general Functional Priority order and determine the distribution of NATC assets. But, as Ref. 2 emphasizes, "only incremental adjustments to manpower will occur. These adjustments occur only in an upward direction when an optimum manning level in a function is prioritized ahead of the present level in another function. Decreases cannot occur if all minimum levels must precede the present or optimum levels in the prioritization of decision packages. Obviously, this approach is not realistic

in that frequently the work which can be done at the minimum level in one function is not as beneficial to naval aviation as the present or optimum effort levels of another function.

This disjoint, incremental process of manpower allocation cannot be effective until the project priority list has a large influence on the order in which decision packages are prioritized for the entire NATC organization."

Based on the previous discussion, it could be added here that the present manpower allocation process cannot be effective until the relative asset demand criterion along with the project priority criterion is introduced to the manpower allocation process (through the project selection process).

3. Proposed Models for Optimal Project Planning

Three models have been developed and implemented as the main research work of this thesis. The idea of improving the workload planning at NATC by using Linear Programming was expressed in Ref. 2, where the first effort to formulate the NATC problem in mathematical terms was made.

a. Civilian Personnel Based Model (MODEL-1)

Maximize (1) $\sum_{j} \pi_j \cdot X_j \qquad j = 1,2, \ldots, N$

Subject to (2) $\sum_{j} a_{jit} \cdot X_j \leq b_{it} \qquad j = 1,2, \ldots, N$

$i = 1,2, \ldots, 36$

$t = t^*, t^*+1, \ldots, T$

(3) $X_j \in \{0,1\}$ $j = 1,2, \ldots, N$

where

X_j is (zero,one) variable representing a project. It has the value of one if the project X_j is included in the optimal planning solution or has the value of zero if it is not;

N is the total number of projects in the Master File, and

π_j is the benefit of accomplishing project X_j. In paragraph II.B.4.a of this thesis the method used to calculate the relative benefits of the projects is described.

a_{jit} is manyears of civilian labor demanded by project X_j, at FACC i, in year t. Master File gives estimates of this coefficient.

t^* is the START-YEAR for each project. It can take one of the integer values 1 through 5, depending on the start-year of the project relative to our planning years (1 stands for the first year of the plan and 5 represents the last year of the plan).

T is the END-YEAR for each project. It can take one of the integer values 1 through 5, depending on the end-year of the project relative to the planning years (1 and 5 the same as above).

Example: If the 5-year plan starts the fiscal year 1978 and ends the fiscal year 1982, then a project with ID number 031 which starts the year 1979 and ends the year 1982 has $t^* = 2$, $T = 5$. For projects which continue beyond the planning horizon, $T = 5$.

b_{it} is the civilian direct labor (in manyears), available at FACC i in year t. Table I, taken from Ref. 2 contains this information for NATC.

It should be mentioned here -- and this is true for all three models -- that Linear Programming (LP) continuous relaxations (with the continuous bounds $0 \leq X_j \leq 1$ substituted for $X_j \in \{0,1\}$), were first implemented and then the reported Integer Programming (IP) solutions were found. One main characteristic of all three models is that the optimum solutions to the LP relaxation contains only very few projects (less than 5%), with fractional values $0 < X_j < 1$. This is a very fortunate property of the models. First, the models can be used everywhere an LP system (not necessarily IP) is available. Second, the management can use the LP solution, which always represents a more 'optimum' benefit than the corresponding IP solution, *if* for the small proportion of the projects with the fractional values, projects can actually be fractionally implemented by extending the time to accomplish these projects, working at less than normal rate, etc.

MODEL-1 has been implemented exactly as is described above. The implementation is discussed in paragraph II.B.4.b and the result in paragraph II.B.4.c of this thesis.

The model selects only complete projects, since the variable X_j can take only the values zero or one. This restriction was imposed to the model because the time phasing of the projects is *not* variable at NATC level.

If a project is not included in the optimum portfolio, it can be examined again the next year, after

updating workload planning data or probably changing the project priority.

Function (1) is the Objective Function of this model. It calculates the total benefit of all projects selected at each step of the model's selection process. The optimal selection maximizes the value of this function without violating any of the constraints.

Inequalities (2) express the civilian personnel ceiling constraints. There is a total of 36 x 5 = 180 of these constraints, one for each FACC and each year.

The last function area (2T), included in the Master File was found empty -- no project demanded labor at this Function Area -- so the number of FACC's has been reduced from 36 in MODEL-1 to 35 in MODEL-2 and MODEL-3.

It is noted that projects may exhibit inter-dependence in that one may be *required* before another can be considered. Although addition of constraints to enforce these "if, then" relationships is straightforward -- and, in fact, eases the model solution effort -- NATC did not request such solution features and no supporting dependence relationships were available relating the projects proposed.

Similarly, "either/or" restrictions among projects -- or alternate methods of performing equivalent work -- were not introduced in the pilot study.

b. Model Based on All Constraints but not Allowing Reallocation of Personnel (MODEL-2)

Maximize (1) $\sum_{j} \pi_j \cdot X_j$ $\quad j = 1,2, \ldots, N$

Subject to (2) $\sum_{j} a_{jkit} \cdot X_j \leq b_{kit}$ $\quad j = 1,2, \ldots, N$; $k = 1,2$; $i = 1,2, \ldots, 35$; $t = t^*, t^*+1, \ldots, T$

(3) $\sum_{j} X_{jn} \leq H \cdot I_n$ $\quad n = 1,2, \ldots, M$

(4) $\sum_{n} f_{nt} \cdot I_n \leq F_t$ $\quad t = 2,3,4,5$

(5) $X_j \in \{0,1\}$, $I_n \in \{0,1\}$

$j = 1,2, \ldots, N$

where:

X_j is the variable name for the projects, as in MODEL-1.

X_{jn} is representing project X_j which requires the Improvement and Modernization Project (IMP), I_n, in addition to other requirements.

I_n is representing the IMP project n. This new variable is also (zero, one). If I_n is zero, then all X_{jn} must be also zero. If I_n is one, then some or all of the X_{jn} can be one. Each project can require up to four different IMP projects.

H is the total number of the projects X_{jn} which require IMP project I_n.

M is the total number of IMP projects included in the Master File.

f_{nt} is the amount of money needed for IMP project I_n at year t. Here t takes the values from 2 to 5.

Table IV lists the NATC IMP's, with the estimated funding profile required to meet the schedules of various needs of the dependent X_j projects.

F_j represents the IMP Budget for year t or, in other words, the total amount of money available for IMP projects at year t, $t = 2,3,4,5$.

π_j is the benefit of the project X_j, as in MODEL-1.

a_{jkit} is the labor (in manyears), of type k, demanded by project j, at FACC i, in year t.

k represents the type of labor. We have considered two types of labor, namely civilian and military.

b_{kit} stands for the direct labor (in manyears), of type k, available at FACC i, in year t.

N total number of projects in the Master File

t^* START-YEAR of each project, as in MODEL-1

T is the END-YEAR of each project, as in MODEL-1.

Function (1), the Objective Function, calculates as in MODEL-1 the total benefit which we get when we accomplish the projects included in the solution.

Inequalities (2) stand for the civilian and military labor ceiling constaints; there are two constraints of this type for every FACC and every year, one for civilian and the other for military personnel. Thus there is a total of 2 x 5 x 35 = 350 constraints of this type in the pilot model.

Inequalities (3) represent the Improvement and Modernization Project (IMP) requirements of the projects. IMPs require large capital investments in laboratories and equipment and there is available a limited Improvement and Modernization (I&M) budget each year. These projects have been planned to improve the efficiency of test and evaluation at NATC. The ability to do a project is in many cases directly affected by the IMPs related to that project and so the relationship between projects and the IMPs should be introduced.

Constraints of type (3) do not allow any of the projects that require I&M project I_n to be in the planning solution, if I_n itself is not in the planning solution. There are 61 of these constraints in the model because there are 61 IMPs related to the projects in the Master File.

Constraints (4) are the I&M budget constraints. There are 4 of them, one for each of the planning years 2 through 5.

c. Model Based on All Constraints and Allowing Reallocation of Personnel (MODEL-3)

Maximize (1) $\sum_{j} \pi_j \cdot X_j - \gamma \cdot \sum_{k,i,l,t} C_{kilt} \cdot Y_{kilt}$

Subject to (2) $\sum_{i} \alpha_{kilt} \cdot Y_{kilt} - \sum_{j} a_{jklt} \cdot X_j \geq 0$

(3) $\sum_{l} Y_{kilt} \leq b_{kit}$

(4) $\sum_{j} X_{jn} \leq H \cdot I_n$

(5) $\sum_{n} f_{nt} \cdot I_n \leq F_t \qquad t = 2,3,4,5$

(6) $X_j \in \{0,1\}, \quad I_n \in \{0,1\}$

for $j = 1,2, \ldots, N \qquad n = 1,2, \ldots, M \qquad l = 1,2, \ldots, 35$

$k = 1,2 \qquad i = 1,2, \ldots, 35 \qquad t = t^*, t^*+1, \ldots, T$

except in (5).

Where:

X_j, X_{jn}, I_n, H, M, N, f_{nt}, F_t, π_j, a_{jklt}, b_{kit}

have the same meaning they had in MODEL-2,

Y_{kilt} is the variable name which represents the manyears of labor of type k, which have to be reallocated from FACC i to FACC l, at year t, in order for the optimal planning solution to be accomplished. For i = l this variable represents workforce not actually reallocated,

C_{kilt} represents the inefficiency we have if we reallocate one manyear of labor of type k, from FACC i to FACC l, at year t. In later sections it is described how this reallocation 'cost' has been implemented,

α_{kilt} $= 1/(1 + C_{kilt})$ is the 'net' labor available at FACC l, if one manyear of labor of type k is reallocated from FACC i to FACC l, at year t, and

γ is a scale factor, a tool to express the management policy in maximizing the total benefits and minimizing the reallocations. It represents the desired balance between total benefit and total reallocation penalty.

A brief discussion follows, explaining the meaning of the terms in the objective function and the constraints introduced in MODEL-3 and the main ideas behind them.

In the Objective Function (1) the first term sums up the benefits of the projects in the planning solution in exactly the same way as in MODEL-1 and MODEL-2. A second term with a minus sign has been introduced in the objective function of this model. Since the idea of allowing reallocation of personnel -- in order to improve the optimal planning solution -- is added, we want to minimize the reallocations to the absolutely necessary level. To discourage the model of ordering reallocations freely, the idea of paying a penalty for every reallocation ordered is

introduced. In the section where the implementation of this model is discussed, it is described how this idea was actually implemented.

Inequalities (2) assure that the supply of labor of type k, at FACC i, in year t, is greater than or equal to the demand of labor of the same type, at the same FACC, in the same year.

The first term expresses the supply of labor in terms of all movements of personnel from all other FACCs to FACC 1, in year t -- including the personnel which were and remain in FACC 1. α is a factor which transforms the labor reallocated to 'net' labor, actually available in the new place. This factor has been introduced for two purposes. First, there are inefficiences because of the reallocations themselves and these inefficiencies must be deducted from the labor supply to match the demand units. Second, this deduction is used as a tool to discourage the model from preferring large numbers of reallocations during the selection process.

The second term in the inequalities (2) is an expression of the demand of labor in terms of all selected projects X_j which require labor of type k, at FACC 1, in year t.

There is a total of 2 x 35 x 5 = 350 constraints of type (2) in this model.

Inequalities (3) have been introduced to restrict the total personnel moving from FACC i -- including the

personnel which remain at FACC i -- in year t, to the level of manyears of labor of the same type available at the same FACC in the same year.

Finally, the constraints (4) and (5) are the same as the constraints (3) and (4) of MODEL-2. They represent the Improvement and Modernization Project (IMP) requirements of the X_j projects, and the IMP budget constraints respectively.

More details about each model are given in the next section of this thesis where the implementation of the models is described.

4. Implementation of the Proposed Models

In this section the main steps of the implementation effort will be described. The reasoning of every major point will be given and the development of the computer programs prepared to solve the models will be explained.

It has already been noted that an LP relaxation of each model was first sought, and after an optimal solution was reached an IP solution was attempted. The integer solution was considered as one which better fits the current situation, because NATC does not have the authority to extend the execution time scheduled for each project. For that reason we present and discuss here the results of the IP solutions. Nevertheless, the LP continuous solutions can be used to make proposals for partial execution of some projects to achieve higher optimal benefits, *if* this partial execution is permitted by other factors.

Before coming to the description of the implementation effort, it should be emphasized that we have had continued contact with NATC management and the models have been developed with their help.

a. Calculation of the Benefits of the Projects, Description of the Computer Program BEN

The NATC Project Priority List (PPL), has used as the basis for competition among the projects for the allocation of the resources at directorate/department level. Project priority, although subjective, is a fairly accurate estimate of the benefits of a project to the Naval Aviation Program. Besides, there exists a procedure of dynamically updating the PPL.

This was the reasoning for the proposal made in Ref. 2 to use project priority as the relative benefit criterion in the project selection process. Since priority is currently assigned only after a project has been selected to be active, the first step in the implementation of the models is to assign estimates of the relative priority for all the projects in the Master File and for each year between the Start and the End-year of each project. For the purposes of the present work a file has been used with these priority estimates provided by the author of Ref. 2.

As mentioned previously, a transformation was made from the relative priorities to the relative benefit of each project. The transformation has two purposes. First to get numbers which can be added to show the aggregate

benefit an entire project portfolio, since adding priorities is meaningless. And second to be able to give more weight to priority estimates of the first planning year and less to priority estimates of the future years, since the reliability of the planning data decreases as one goes from the first to the last planning year.

The transformation which has been implemented was proposed in Ref. 2. First a number called Average Discounted Priority (ADP) is calculated for each project by using the priority estimates for the project over the years in which the project is scheduled to be active, if selected. ADP is given by the formula,

$$P_j = \frac{\sum_t P_{jt} \cdot (1.2)^t}{n} \qquad \text{for} \quad t = t^*, t^*+1, \ldots, T$$

where

P_j is the ADP of the project X_j. It refers to the start-year t^* of the project,

P_{jt} is the given priority of project X_j in year t,

t^* is the start-year for project X_j,

T is the end-year for project X_j, and

n is the number of years in which the project is scheduled to be active, thus $n = T-t^*+1$, with t^* and T each taking one of the integer numbers 1 through 5.

The factor 1.2 represents a 20% annual rate of discounting applied to priority, which seems to be a reasonable rate characterizing the decrease in the accuracy with which estimates of project priority for future years can be made.

From the ADP the BENEFIT of each project is calculated using the formula

$$\pi_j = 1 - \left[\frac{P_j}{\max\limits_{t^*} P_i}\right]^2 ;$$

where

π_j is the relative BENEFIT of the project X_j given as a number between zero and one,

P_j is the ADP of the project X_j,

t^* is the start-year of the project X_j, and

$\max\limits_{t^*} P_i$ is the maximum ADP among all projects X_i with the same start year t^*.

Computer program BEN was developed to calculate the benefits of all the projects in the Master File. BEN is written in FORTRAN and it was used under the CP/CMS environment of the IBM 360/67 at the Naval Postgraduate School Computer Center. It can be used in any IBM compatible batch or time sharing computer system after defining properly the input and output files.

Before coming to the description of the programs developed to implement the three models, it should be said

that the intention was to give as complete a description as possible of these programs. This probably is not needed for the purposes of the thesis and lies beyond the interests of the general reader. But it is very important for those people who wish to make use of those models in an effort to improve their planning process. And in these cases it is known that any given documentation -- even if it is well prepared -- it is always insufficient.

Instead of inserting comments in different points of each program's body and supporting these comments with a general description, it was found more effective to have all the information concentrated and related to each specific part of each program. For this purpose each program was divided into parts, based on the logical flow and the function at each point. The parts are indicated in each program's LISTING given at the end of this thesis.

Program BEN reads in PART 1, one input file -- FILE 1 -- with the priority of each project in the Master File for each year in which the project is scheduled to be active, if selected by the planning process. NPRTS is a table of 6 places used to read in the project ID number in the first place and the project priorities in the other 5 places. KSTAR and KEND are names given to Start-year and End-year respectively. The program calculates in this part the Average Discounted Priority, under the name NPRIAV, and creates an intermediate file -- FILE 4 -- with the project ID, KSTART, KEND and NPRIAV.

PART 2 of the program finds the maximum of the NPRIAVs (Average Discounted Priorities), of the projects which start at the same year. These 5 numbers (one for each planning year), are stored in the table NPRMAX.

Finally, in PART 3, the program calculates the Benefit of each project, under the name BENEF, and creates an output file -- FILE 2 -- with the project ID, KSTART, KEND and the BENEF.

The mathematical base for all the calculations has been explained previously.

Samples of the Input, Intermediate and Output files are given at the end of the program's LISTING.

b. Preparation of the Input Data for MODEL-1, MODEL-2, MODEL-3, Description of the Computer Programs REFMT, PREP-1, PREP-2 and PREP-3.

After calculating the project benefits -- as has been described in the previous section -- the implementation effort was concentrated on the manipulation of the Input Data needed for MODEL-1. The major part of these data, namely concerning the project demands for each kind of resource, was available in a magnetic tape already referred to as the Master File. The tape was written using the COBOL language. Since it was decided to use FORTRAN in the implementation programs, it was necessary to develop an interface between the two languages, otherwise it was not possible to use the file. Data in IBM packed decimal COBOL character format cannot be read directly by FORTRAN procedures.

This interface was accomplished through the program REFMT developed by Kristina L. Butler, a staff member at the Naval Postgraduate School Computer Center.

The REFMT program is written in PL|1. Having this interface between the actual data and the programs developed to implement the models, a degree of Data Independence was developed which is a major principle in computer systems and Data Bases. If changes are made in the Master File Record Layout, it will not be necessary to make changes in the large and complex implementation programs. Rather it will be easier to adjust the interface program REFMT to the new situation. Such changes are not rare in situations like this, when the organization is in constant development toward a computerized decision making process. (It is enough to say that before this work was completed the Master File Record was extended from 2504 to 3005 characters.)

Programs PREP-1, PREP-2 and PREP-3 were developed to create and prepare the input data for MODEL-1, MODEL-2 and MODEL-3 respectively. Creation here means reading the raw data and creating from them data suitable to the models formulation as each of them has been described. Preparation means writing the created data in the format required by the Mathematical Programming Systems, namely the MPS/360 described in Ref. 7 and the XS System described in Ref. 8. Fortunately both systems have the same format in the input data and this fact facilitated the effort and also provides

to the programs a major degree of portability, since they can be used wherever one of the two systems (or any of many competing systems accepting this relatively standard problem format), is available. A brief discussion will be presented later about which of the two systems is more effective in solving this large scale planning problem.

(1) Description of the Interface Program REFMT

Program REFMT selects data fields from the Master File magnetic tape and constructs a new file. In some fields the data type is converted to facilitate the access by programs in FORTRAN. The new file is created in magnetic disc.

PART 1 declares the input and output files and the variables required by the program.

PART 2 reads a record from tape, selects record ID number converting its data type, and selects also the related IMPs.

PART 3 selects Cost Center, plus military, civilian and contractor requirements.

PART 4 selects A/C type and flight hours. A/C type is reformatted to left-justify type, eliminate dashes and/or blanks, and drop fifth character if present. Flight hours type is converted.

PART 5 selects and converts data type of expected revenue.

PART 6 selects and converts data type of the cost fields. Then a record containing all the selections

is written and the program returns to read a new input record.

PART 7 prints counts of input and output records and stops the run.

(2) Description of the Program PREP-1

The program declares at first the arrays needed for memory storage of the input, intermediate and output data. CIV(8,20) is the table to store the civilian labor demands of one project. The first index is the year -- 8 years planning data are stored in the Master File -- and the second index is the Function Area -- there are 20 FAs which produce 35 FACCs when Cost Center is introduced. MIL(8,20) stands for military labor demands of one project and CON(8,20) stands for contractor labor demands of one project. HOURS3(8,4) stores the flight hours demanded by one project per year and per aircraft type -- up to 4 aircraft types -- while COST4(8,8) stores the project costs by fiscal year and by cost category, and COST5(8,4) stores the portion of contractor costs under COST4 which will be passed on to the other government activities for project assistance. Detailed description of these items is given in Ref. 6.

PART 1 introduces the names of the problem constraints -- which are also called ROWS of the problem's Tableau. BENE is the first row name, the name of the Objective Function row. Each of the other row names is constructed of 3 letters and one digit. The first letter

represents the Function Area (e.g., A means the FA with name 2A), the next two letters express the Cost Center (e.g., AT is the AT Cost Center), and the number represents the year (e.g., 1 means the first year). For example BSA3 is the name of the constraint on civilian labor at FACC 2BSA in year 3. All these row names are stored in the array ROWNAM(181).

PART 2 introduces the project names, also called COLUMNS of the problem's Tableau. Each name has been constructed of the letter X and one 3-digit number which is the ID number of the project i.e., X050 represents the name of the project with ID number 050 or the X_{50} project using the notation described in the formulation of the models. These column names are stored in the array COLNAM(950).

PART 3 reads in one record from the Master File -- FILE 3 -- and one record from the Benefits File -- FILE 2 -- and checks if both records have the same ID number. Then it clears an array COLUMN(181) which is going to be used for temporary storage of the project demand coefficients when they are created in subsequent parts of the program.

PART 4 examines the Cost Center (CC) name under each function area. This is done by comparing each CC name with all valid CC names stored in the array DIGIT(6). When the program finds that the CC name is a valid one, it

calculates the corresponding indices -- INDEX1, INDEX2 -- to store the civilian labor demand in the proper position of the COLUMN array. If the CC name is not a valid one then it prints a message "ERROR IN COST CENTER CODE" following the project ID number and the invalid CC name, and continues. When PART 4 terminates its function the COLUMN array is ready with non-zero entries to all places corresponding to FACCs where the project demands civilian labor, and zeroes elsewhere.

PART 5 creates the first part of the output file -- FILE 10 -- in the format described in Ref. 7 under the name 'Input Data Deck' for the MPS/360 system. This is the ROWS part of the Input Data Deck -- for details see Ref. 7 -- up to the point where the Objective Function coefficient 'card' has been created. The term 'card' is used from now on, instead of the term 'record', with the meaning given in Ref. 7, although the programs do not punch cards. All three programs -- PREP-1, PREP-2 and PREP-3 -- produce images of the Input Data Deck cards in a disc-unit in order to avoid handling a deck of approximately 40,000 cards. For debuging purposes the programs print out on paper, with the same format, everything they write in the disc-unit.

PART 6 creates the columns part of the Input Data Deck. It produces one 'card' for each non-zero element of the COLUMN array.

PART 7 prints out the message "ID OF PRIO AND MASTER DO NOT MATCH" in cases when ID number in the Master File and in the Benefits File do not match each other. This message is followed by the printing of all CC names and civilian labor demands -- CIV array -- of the unmatched record, in order to be able to check the Master File entries and make corrections if necessary. Then the program reads in the next Master File record and returns to PART 1.

PART 8 after the production of the 'card' which marks the end of the Integer Variables -- in this model all variables are Integer -- creates the right-hand side 'cards'. To do so, the program reads in one card at a time from FILE 5 which contains the civilian direct labor available at one FACC in years 1 through 5 -- Table I contains the actual data used in the implementation of all models -- and stores it in the array TEMP(5). Then, based on the coresponding FACC name, it calculates the proper INDEX and stores TEMP in the correct places of the array RHSN(180) which finally contains all civilian labor ceilings for the 36 FACCs and 5 years of planning. Then the program creates one 'card' for each entry of the RHSN array.

PART 9 is the last part of the program and it creates the 'cards' concerning the bounds on our project-variables. In this model all the variables are binary (zero,one). To keep track of the project names which have

entered the model, the program uses an array IHELP(865) which keeps the ID number of each project that enters the model. Using the array IHELP the program produces the upper-bounds 'cards' and finishes with the end-of-data 'card'.

Samples of the Input files and all JCL cards are given with the program's LISTING at the end of this thesis.

(2) Description of the Program PREP-2

Before starting the description of the program, it should be said that special care was taken during the development of the PREP-2 and PREP-3 programs to use, whenever possible, the names and the program structure used in PREP-1. The goal was to make PREP-2 as an extension of PREP-1 and PREP-3 as an entension of PREP-2, just like MODEL-2 is an extension of MODEL-1 and MODEL-3 is an extension of MODEL-2. This approach, although more difficult since presenting fewer degrees of freedom, finally has proved to be safer for such large and complex programs for two reasons. First,by maintaining the same names, or root of names, it was easier to keep track of the program's logic and to use the experience of the work in the previous program. And second, by maintaining part of the previous program, when it was possible, wasted work and the possibility of errors was minimized, since these parts had already been checked in the previous model. Finally, this approach made

the programs easier to be followed by someone else who would like to use (and probably make changes) to them.

Program PREP-2 introduces, in PART-1, the names -- subtypes -- we have encountered in the Master File for each of the 36 aircraft types described in Table III. Unfortunately this part of the Master File was not very helpful. It was not written according to its description in Ref. 6 and contained a great number of subtypes for every A/C type. This fact caused a lot of questions for the program in order to identify the A/C types. The program uses the names VTYP1 through VTYP36 for the arrays where the subtypes of each A/C type are stored.

PART 2 introduces a two digit number -- from 01 to 35 -- for each FACC. The sequence in which the FACCs are considered is 2AAT, 2ARW, 2ASA, 2ASY, 2ATP, 2BAT, 2BRW, ..., 2SBS.

PART 3 introduces the project names. This part is exactly the same as PART 2 of the program PREP-1 where more details were given.

PART 4 reads in the information contained in Table III concerning the maintenance military labor required per A/C type and FACC and the maximal flight hours yield per year. This information is going to be used to calculate, based on the total flight hours required by each project, at each FACC in each year, the military labor needed for A/C maintenance at each FACC. If the calculated value is greater than the estimated corresponding military

labor demand given in the Master File, then we use this greater value, since it is a much better estimate.

PART 4 also reads in the information contained in Table IV concerning the Improvement and Modernization Project (IMP) cash requirements and the available total IMP budget of each year. IMP(I,K) is the money required by Improvement and Modernization Project I in year K and IMPTOP(K) is the total money available in year K.

PART 5 is almost the same as PART 3 of PREP-1. The difference is that here we have 416 ROWS instead of 181 as we had in PREP-1. The first row is the Objective Function, the next 175 rows are the civilian personnel constraints, the next 175 rows are the military personnel constraints, the next 61 rows are the constraints which describe Improvement & Modernization projects as prerequisites of the other projects and the final 4 rows are the IMP budget constraints.

PART 6 is similar to PART 4 of PREP-1. As we have described here, it first finds the FACCs where civilian and/or military labor is required by the project and then stores the demands in the proper position of the COLUMN(416) array.

PART 7 zeroes the FLHSUM(36,5) array where, in the next PART, the A/C flight hours by A/C type and by year are stored.

PART 8 finds the A/C types -- as many as four types -- required by the project in each active year and sums up the flight hours in the FLHSUM array.

PART 9 finds the Related Improvement & Modernization Projects -- up to 4 RELIMPs -- by comparing each of them with the entries in the IMPNAM array where the IMP names are stored. Since we found in the Master File IMP names slightly different from those in Table IV we introduced them in the array EXTRA in order to be able to match them with the standard RELIMP names. Each time the program locates a RELIMP name it increases by 1 the counter ICOUNT(J) which corresponds to RELIMP J. J takes the values 1 to 60 in the sequence of the IMPs given in Table IV.

PART 10 calculates the military labor required for A/C maintenance, based on the flight hours sums we have stored by A/C type and by year in the FLHSUM(J,K). Then it sums the man-years founded by FACC. As is shown in Table III the A/C maintenance takes place in 4 Cost Centers of the 2D Functional Area. Finally the program compares the results with the Master File estimates and makes the substitutions if the new estimates are greater.

PART 11 creates the first three 'cards' of the Input Data Deck.

PART 12 creates all the 'cards' which describe the type of each row for those rows which correspond to the civilian and military personnel (rows 2 through 351). The name of each row is constructed here by writing a two letter prefix -- 'RC' for civilian row, 'RM' for military row -- and then writing a two digit

number representing the FACC -- '01' through '35' -- and then writing a one digit number -- 1 through 5 -- for the corresponding year. I.e., RC035 is the row name for the constraint on civilian personnel at FACC 03 -- 03 stands for the FACC 2ASA as we have previously explained -- and in year 5, while RM144 is the row name for the constraint on military personnel at FACC 14 -- FACC 2CSY -- in year 4.

PART 13 creates the 'cards' for the type of each IMP constraint (rows 352 through 416). Each row name is constructed by writing a four letter prefix -- RIMP -- followed by a two digit number -- '01' through '65', since we have 65 of these rows.

PART 14 produces the next two 'cards' of the Input Data Deck.

PART 15 creates one 'card' for every non-zero entry of the first 350 positions of the COLUMN array, which correspond to the civilian and military personnel rows.

PART 16 does the same for the next 61 positions of the COLUMN array, which correspond to the RELIMP constraints.

PART 17 is exactly the same as PART 7 of PREP-1 for which the description has been given.

PART 18 prepares the COLUMN array for each of the 61 IMPS, using all the information we have stored in PART 4 and PART 9, and then creates one 'card' for each non-zero element of this array.

PART 19 reads in the Table I -- which contains the civilian personnel ceilings by FACC and by year -- and stores them properly in the first 175 positions of the RHSN array.

PART 20 reads in the Table II -- which contains the military personnel ceilings by FACC and by year -- and stores them properly in the next 175 positions of the RHSN array. This part also transfers the IMP capital budget ceilings to the RHSN array.

PART 21 creates the right-hand-side 'cards' of the Input Data Deck for the rows 1 through 350.

PART 22 does the same for the rows 351 through 416.

PART 23 creates the upper-bound 'cards' for the primary projects -- using the term primary for the X001 through X950 projects -- based on the information stored in the array IHELP as we have explained when describing PART 9 of PREP-1.

PART 24 does the same for the IMP projects which have entered the model. If the counter ICOUNT(J) is zero, program knows that IMP project J has not entered the model -- has not been asked by any primary project which is included in the model. It also produces the last two 'cards' of the Deck.

Samples of the Input files -- FILE 2 and FILE 5 -- and all JCL cards are given with the program's LISTING at the end of this thesis.

(3) Description of the Program PREP-3

In order to facilitate the implementation effort by using the maximum possible portion of the PREP-2 program in the development of PREP-3, the following rearrangement was made in the formulation of the MODEL-3, described in paragraph II.B.3.c.

Maximize $\quad \sum_j \pi_j \cdot X_j - \gamma \cdot \sum_{k,i,l,t} C_{kilt} \cdot Y_{kilt}$

Subject to

(1) $\sum_j a_{jklt} \cdot X_j - \sum_i \alpha_{kilt} \cdot Y_{kilt} \leq 0$

(2) $\sum_j X_{jn} - H \cdot I_n \leq 0$

(3) $\sum_n f_{nt} \cdot I_n \leq F_t$

(4) $\sum_l Y_{kilt} \leq b_{kit}$

(5) $X_j \in \{0,1\}, \quad I_n \in \{0,1\}$

In this rearrangement the order and the sign of the two terms in the constraints (1), and the order of the constraints has been changed. From now on, the

description of PREP-3 will be related to this new form of MODEL-3.

The first 13 parts of PREP 3 are almost identical to the corresponding parts of PREP-2 and there is no need to repeat the description. The only major change is in the COLUMN array which now has been expanded to 766 positions -- the number of the new problem's rows. Another difference, which appears first in PART 12, is in the row names. Here the row names are constructed in the same way described in PREP-2 but for the first 350 -- corresponding to constraints (1) -- and for the last 350 -- corresponding to constraints (4) -- a one digit number called CONSTR has been added after the letter prefix. This number takes the value 1 for the rows 1 through 350, and 4 for the rows 417 through 766 and indicates the constraint number which each of these rows belongs to. For example RM1144 is the row name for the constraint (1) on military personnel at FACC 14 -- 2CSY -- in year 4.

PART 14 first creates the row 'cards' for the rows corresponding to constraints (4) and then produces the first two 'cards' of the column section of the Input Data Deck.

PARTs 15 through 18 are the same as with the corresponding parts of PREP-2.

PART 19 reads in Table V concerning the reallocation 'cost' expressed in terms of inefficiency.

Each entry of this table is a value of the symbol C_{kilt} in the notation used in the formulation of MODEL-3. The 'net' workforce available at FACC l after reallocating one manyear of labor of type k from FACC i to FACC l in year t is calculated by $\alpha_{kilt} = 1/(1 + C_{kilt})$.

The program transforms the Table V with 19 rows and 19 columns (representing the 19 function areas) to an array with the name RECOST(35,35) with the inefficiency of reallocating civilian personnel from every FACC to any other. Where the reallocation is not permitted an entry 9.0 is introduced as a flag for later use.

For the military personnel we assume that the reallocation is possible from every FACC to any other without inefficiency. But this does not mean that the reallocation of military personnel is free. In fact, as the objective function shows, for every manyear of reallocation -- civilian or military -- we pay the penalty $(\gamma \cdot C_{kilt})$. If i = l -- no actual reallocation occurs -- then we do not pay penalty since $C_{kilt} = 0$. In the cases where we have an actual reallocation of one manyear of military personnel, although inefficiency is not introduced -- $C_{kilt} = 0$ -- a penalty γ is introduced in order to discourage to model in ordering many military personnel reallocations.

PART 20 prepares three entries in the COLUMN array for every possible civilian personnel reallocation and then creates one 'card' for each of these entries.

It should be explained here how the names of the reallocation variables are constructed and this explanation applies to all parts of this program. Each of these names consists of a two letter prefix -- 'YC' for civilian personnel and 'YM' for military personnel -- followed by a two digit number representing the FACC which the personnel comes from, followed by a two digit number representing the FACC which the personnel goes to, followed by a one digit number expressing the year in which the reallocation takes place. For example YC05232 is the variable name for the civilian personnel reallocated from FACC 05 -- 2ATP --, to FACC 23 -- 2GSY --, in year 2.

PART 21 prepares the entries for every military personnel reallocation variable and then creates the corresponding 'cards'. This part is a good example of the effect on program logic of adoption of a good modular coding scheme for constructing variable names. The fact that a few program statements produce over 6000 variable names and handle each of them properly bears testament to the effectiveness of our variable naming convention. The same idea has been applied in constructing all the variable and the row names of all the models.

PARTs 22 through 25 are exactly the same as PARTs 19 through 22 correspondingly of PREP-2.

PART 26 produces the right-hand-side 'cards' for the rows 416 through 766.

PARTs 27 and 28 are the same as PARTs 23 and 24 of PREP-2 correspondingly and create the upper-bound 'cards' of the Input Data Deck, as has been explained in PREP-2.

Samples of the input files and all Job Control Language (JCL) cards are given with the program's LISTING at the end of the thesis.

c. Comparative Results from MODEL-1, MODEL-2, MODEL-3, PRESENT METHOD

Table VI contains side by side the optimal solutions of MODEL-1, MODEL-2 and MODEL-3, and the solution which has been given by the management of NATC using the present method of planning without such models.

MODEL-1 served as the first step in the implementation effort and was important for two purposes. First, it served as a base in checking the correctness of the more complicated MODEL-2 and MODEL-3. And second, by comparing the optimal solutions of MODEL-1 and MODEL-2 one can parametrically evaluate the relative impact of the civilian and military workforce availability on the solution. MODEL-3 is not easy to be compared in details with any one of the other models or with the present method because only this model includes the idea of the reallocation of personnel. However in later sections of this thesis a discussion is included on how one can use the solution of MODEL-3 successfully.

Comparing the optimal solutions of MODEL-1 and MODEL-2 it is found that 389 out of 462 projects selected

by MODEL-1 are also selected by MODEL-2 (both models say YES to each of these 389 projects). On the other hand MODEL-2 does not select 92 of the 106 projects which MODEL-1 also does not select. Thus there is 84% agreement on YES's and 86.8% agreement on the NO's. This is a very strong indication that the implementations of the models are both correct or both incorrect. The total benefit of the optimal solutions is 400.86 for MODEL-1 and 341.74 for MODEL-2.

A diminution of 59.12 units of benefit or 14.75% occurred when the military personnel constraints were introduced (including A/C maintenance) with the IMP constraints. This confirms the (well known at NATC) fact that civilian labor is the crucial resource for this organization. In terms of number of projects selected, the optimum solution includes 462 projects in MODEL-1 and 403 in MODEL-2, thus there is a decrease of 59 projects or 12.77%, not much different from the above 14.75%.

The total benefit of the solution given by NATC with the present method without models is 362.82 (not including the projects on which a decision has been deferred). But this solution *is not feasible*. Approximately 20-25% of the work which had to be done during the first year remained unaccomplished -- mainly because many constraints had been violated, although contractor labor was used in substituting for NATC civilian personnel and also overtime work was used to increase the available workforce.

For the year 1978 a rough estimate was given of 10% -- calculated on the total NATC workforce -- increase in the workforce through the use of contractor labor substituting for NATC personnel, and another increase of 8-10% due to overtime work. Thus, applying linear relationships between workforce increase and productivity increase in terms of increase in the number of projects that can be accomplished, an estimated 38-45% of the workload decided by NATC to be done during the first year was not possible accomplish without the help of contractor personnel and overtime. In order to be lenient and to exclude any possible error in the given estimates we deduct only 20% -- half of the above -- from the total benefit of the present NATC method's solution to achieve a basis comparable with the model's. The remainder is 290.25 units of total benefit.

MODEL-2 gives a total benefit of 341.74 units and in order to be able to compare this with the present method's solution, we have to extract the benefit of the projects included in MODEL-2 solution but for which we have no present method's decision. These projects sum a benefit of 14.83 units and so the remainder for MODEL-2 is 326.91 units. Now the comparable numbers are 290.25 and 326.91. The second represents a solution improved by 36.66 units of benefits or 12.6% above the present method's total benefit. In addition to this improvement the MODEL-1 solution has the following advantages. First, it is less expensive.

We do not plan additional contractor labor and overtime. Also, it is less expensive because the present NATC method's solution requires all IMPs that MODEL-2 solution requires as well as 6 additional improvement projects, namely the A1, A3, C4, F1, G5, I7, as one can see in the last part of Table VI. Second, the solution to MODEL-2 is more realistic.

The present NATC method's solution indicates NO to only 34 of the first half -- in ID number order -- of the projects and to 95 of the second half of them. Thus, the probability of a project not to be selected is 0.12 if the project belongs to the first half of the projects in sequence based on the ID number, and 0.33 if the project belongs to the second half of the same sequence. This difference is unreasonable. It strongly suggests that the projects are examined in the order of their ID number and that this order biases the selection. (There is no relation between the ID number of a project and its benefit, priority or importance.) This has been evident in all three models. MODEL-1 indicates NO to 56 of the first half of the projects and to 50 of the second half, MODEL-2 gives 92 versus 73 and MODEL-3 gives 26 versus 29. None of the models indicates any relation between the order of the projects -- based on the ID number -- and the selection process.

MODEL-3 solution gives a total benefit of 441.47 units which corresponds to an increase of 29.18% over MODEL-2 giving 341.74 units. This significant improvement

has been achieved by reallocating the personnel indicated in Table VII. The total manyears reallocated over the 5-year period represent 16.88% of the total civilian labor and 16.95% of the total military labor, calculated over the same 5-year period. These results encourage workforce reallocation as a tool to improve the production in the long run. But it is not necessary to move people from one FACC to another in order to meet the recommended needs of MODEL-3. This can be done by using contractor labor and overtime, but only in those FACCs where the model shows a shortage and indicates how deficient the labor supply will be. Also, *new hires* can be directed to FACCs where permanent shortages are indicated and not to those where people have insufficient projected workload.

The MODEL-3 solution shows that 42.43% of the total reallocations for civilian personnel has to be made in the first year and 16.53%, 12.03%, 14.68%, 14.33% in the following years. The corresponding numbers for the military personnel are 18.34%, 20.15%, 16.47%, 20.84%, 24.20%. This distribution of the reallocation over the 5-year period indicates that the current distribution of the civilian personnel over the FACCs is not in harmony with the 5-year optimum production plan. Because of this the model orders much more reallocation in the first year to achieve the best long-term balance. The numbers for the military labor reallocation do not indicate such a problem for the military personnel.

Scale parameter γ -- see formulation of MODEL-3 -- can be used as a tool to express the management policy on the questions of allowing, or not allowing reallocation, by means of actual reallocations or by using contractor manpower or overtime work instead of actual reallocation. By increasing γ the reallocation penalty is increased and the model is discouraged in ordering reallocation. The implementation presented here has been done using $\gamma = 0.01$ and the results show that this value represents a policy which allows a high project portfolio benefit and reasonable use of the reallocation. It enables the model to show the weak points of the workforce distribution and how the productivity can be increased.

A final remark in the comparison of the solutions given in Table VI is that there are 25 projects for which MODEL-2 and MODEL-3 both say NO and the PRESENT METHOD says YES. This means that the current process selects projects which are not worthy do be selected even if reallocation is permitted. This indicates that either the PRESENT METHOD is inefficient or the solution is infeasible. The conclusion is based on the fact that these projects have not been selected by the process established through the models -- which leads to optimal solutions -- either because other projects with the same or less labor and/or capital demands have more benefit, or because the introduction of these projects leads to the violation of some of the

constraints. Thus, the results of the comparison between the solutions, given previously in this section (where it was found that MODEL-2 is at least 12.6% more efficient than the PRESENT METHOD and that 38-45% of the workload decided by NATC to be done during the first year was not possible to be done), are also supported here.

5. Computer CPU Time and Other Factors Affecting the Comparison of the Models

The implementation of the models was made using the IBM 360/67 computer system at the Naval Postgraduate School.

CPU time is distinguished in preparation time and in solution time. The first is the time needed by the programs PREP-1, PREP-2, PREP-3 to prepare the data for the models. The second is needed by the Mathematical Programming (M.P.) system to find the optimal solution.

The CPU time for each model and each M.P. system was:

a. Continuous L.P. Solution

	XS		MPS/360			
	SEC	PIVOTS	SEC	PIVOTS	ROWS	COLS
MODEL-1	7	212	49	176	181	568
MODEL-2	12	276	109	323	416	591
MODEL-3	1101	2581	5530	2561	766	10922

System XS is 7 times faster than MPS/360 in MODEL-1, more than 8 times faster in MODEL-2 and more than 5 times faster in MODEL-3.

b. Integer Solution (System XS only)

	SEC*	PIVOTS	% RESOLUTION	INTEGER VARIABLES
MODEL-1	67	288	1.8	568
MODEL-2	83	224	5.1	591
MODEL-3	191	670	0.5	592

* Additional time, after reaching optimum continuous solution.

Using a typical cost of 90 dollars per CPU hour, the running cost by model, by M.P. system and by solution is (all times are given in seconds):

		CONTINUOUS SOLUTION				INTEGER SOLUTION	
		XS		MPS/360		XS	
	PREP. TIME	TOTAL TIME	COST	TOTAL TIME	COST	TOTAL TIME	COST
MODEL-1	54	61	1.52	103	2.57	128	3.20
MODEL-2	138	150	3.75	247	6.17	233	5.82
MODEL-3	360	1461	38.52	5890	147.25	1652	41.30

It is clear that MODEL-1 and MODEL-2 are very economic, while MODEL-3 is relatively expensive. But a model with 766 rows and 10922 variables (not including slacks), of which 592 are integer variables, is not easily solved. It is explained later in this thesis that the proposed new resource allocation process would not require running MODEL-3 very often.

It should be mentioned here that NATC has the IBM 360/195 computer system which is 10 times faster than the 360/67. So, these models could be used by NATC more conveniently than at the Naval Postgraduate School.

III. CONCLUSIONS

The implementation of the three models in solving the planning problem of NATC has proved to be very successful.

MODEL-2 includes all the important constraints of the problem and provides quick, feasible, better and more economic plans than the current process seems to.

MODEL-3 discovers what reallocation the management has to do and where, in order to improve the solution given by MODEL-2. It also discovers inconsistencies in the personnel distribution and the 5-year workload, by location and by year. It is a powerful tool for the management in making long-term adjustments in the workforce distribution and in controlling the use of the contractor labor and of the overtime work.

The NATC management can easily express through MODEL-3, by changing the coefficient γ, its policy toward reallocation of personnel -- actual reallocation and/or substitution by contractor labor and/or overtime work.

Both models -- MODEL-2 and MODEL-3 -- can be easily expanded to include mutually exclusive and/or joint projects.

Both models reflect an unbiased and optimal project selection process and confirm the fact that the present method is subjective, biased and far from being optimal in a mathematical sense.

All the objectives set for this thesis, as they have been described at the beginning, have been accomplished.

An automatic computer system consisting of a joint use of MODEL-2 and MODEL-3 programs, as it is recommended in the next chapter, is now available to be used by NATC. A transition period with the parallel use of the proposed and the current planning processes can help the managers of all levels to see the advantages of the new system and make them eager supporters of it.

IV. RECOMMENDATIONS

MODEL-2 and MODEL-3 should be considered as two equally important systems, each serving the management in approaching different aspects of the resource allocation process.

MODEL-3 can be used as the first step in the planning process. It can reflect the management policy on the issues of using contractor manpower, of reallocating the existing personnel and of using overtime work, and it can give the impact of this policy on both the workforce distribution and the optimum planning solution.

MODEL-2 on the other hand gives the optimum plan which can be accomplished by a static workforce distribution. So, it can be used as the second and final step in the decision process, after management has decided on the workforce distribution with the help of MODEL-3.

One good way of using the two systems is in the following sequence:

1. Run MODEL-3 once a year, at the beginning of the planning process, using updated Project Priority List.
2. Based on the MODEL-3 solution, make the decisions on the issues of reallocations, of using contractor manpower and of using overtime work, by location and by year.

3. After the decisions are made, update the civilian and military personnel ceilings. It is now possible for these 'ceilings' to include contractor personnel in substitution of civilian and/or military and also may include overtime expressed in terms of additional manyears available at certain locations in certain years.
4. Run MODEL-2 using the updated 'ceilings' and get the optimum planning solution.
5. If the solution given is not completely satisficing, make corrections in the Master File -- labor demands -- and/or in the personnel 'ceilings', and run MODEL-2 again.
6. Every month, after updating the Project Priority List, use MODEL-2 to see the effect on the plan.
7. Repeat the cycle from 1 to 6 every time management wants to make adjustments in the workforce distribution or to change the policy.

The quality of the models' results can further be improved by making efforts to better estimate the reallocation inefficiencies and the labor demands of the projects, especially for the years closer to the end of the planning horizon.

TABLE I

FACC	FY78	FY79	FY80	FY81	FY82
	CIVILIAN DIRECT LABOR AVAILABLE (Man-years)				
2AAT	8	8	9	9	10
2BAT	43	45	46	48	49
2CAT	12	12	12	12	12
2DAT	17	17	17	17	17
2ARW	10.5	12	12	12	12
2BRW	13	15	15	15	15
2CRW	5	5	5	5	5
2DRW	3.4	3.4	3.4	3.4	3.4
2ASA	25	25	25	25	25
2BSA	23	23	23	23	23
2CSA	15	15	15	15	15
2DSA	41	41	41	41	41
2ASY	0	0	0	0	0
2BSY	10.1	10.1	10.1	10.1	10.1
2CSY	.8	.8	.8	.8	.8
2DSY	0	0	0	0	0
2ATP	9	9	10	10	10
2BTP	2	2	2	3	3
2CTP	0	0	0	0	0
2DTP	11	11	8	8	8
2ESY	26.2	26.2	26.2	26.2	26.2
2FSY	33.6	33.6	33.6	33.6	33.6
2GSY	24.7	24.7	24.7	24.7	24.7
2HSY	16.1	16.1	16.1	16.1	16.1
2ISY	12.3	12.3	12.3	12.3	12.3
2JSA	26.0	26.0	26.0	26.0	26.0
2KSA	33	33	33	33	33
2LSY	0	0	0	0	0
2MTS	44	41	41	41	41
2NRA	17	17	17	17	17
2OTS	8	10	12	12	12
2PCS	20.8	20.8	20.8	20.8	20.8
2QTS	53	50	51	51	50
2RTC	19	19.5	19.5	19.5	19.5
2SBS	50	50	50	50	50

TABLE II

MILITARY DIRECT LABOR AVAILABLE

(Man-years)

FACC	FY78	FY79	FY80	FY81	FY82
2AAT	7	7	7	7	7
2BAT	8	8	8	8	8
2CAT	3	3	3	3	3
2DAT	70	70	70	70	70
2ARW	4	4	4	4	4
2BRW	4	4	4	4	4
2CRW	1.5	1.5	1.5	1.5	1.5
2DRW	30	30	30	30	30
2ASA	10	10	10	10	10
2BSA	7	7	7	7	7
2CSA	7	7	7	7	7
2DSA	190	190	190	190	190
2ASY	0	0	0	0	0
2BSY	2	2	2	2	2
2CSY	0	0	0	0	0
2DSY	0	0	0	0	0
2ATP	14	14	14	14	14
2BTP	3	3	3	3	3
2CTP	0	0	0	0	0
2DTP	71	51	21	13	13
2ESY	0	0	0	0	0
2FSY	0	0	0	0	0
2GSY	2	2	2	2	2
2HSY	7	7	7	7	7
2ISY	5	5	5	5	5
2JSY	5	5	5	5	5
2KSA	5	5	5	5	5
2LSY	0	0	0	0	0
2MTS	0	0	0	0	0
2NRA	0	0	0	0	0
2OTS	0	0	0	0	0
2PCS	0	0	0	0	0
2QTS	0	0	0	0	0
2RTC	22	19	19	19	19
2SBS	30	30	30	30	30

TABLE III

MAINTENANCE LABOR REQUIRED AND FLIGHT HOUR YIELD
(FUNCTIONAL AREA = 2D)

TYPE A/C	MAX FLT HRS/YR/A/C (Estimated)	FACC	MMY/100 FLT HRS)
A3	250	2DSA	1.29
A4	500	2DSA	.76
A6	350	2DSA	2.21
A7	300	2DSA	1.36
AV8	250	2DSA	2.03
A18	350	2DSA	1.08*
C1	350	2DAT	.73*
C2	250	2DAT	.90*
C130	500	2DAT	.96
E2	250	2DAT	1.56
F4	250	2DSA	2.20
F14	300	2DSA	2.80
F18	350	2DSA	1.08*
H1	400	2DRW	.65
H2	300	2DRW	1.35
H3	200	2DRW	1.17
H46	200	2DTP	.95
H47	200	2DRW	1.23*
H53	200	2DRW	1.28
H58	600	2DTP	.59*
H60	300	2DRW	1.08*
P3	600	2DAT	.97
S3	400	2DAT	1.42
T2	400	2DTP	.54
TA4	600	2DTP	.76
TA7	300	2DSA	1.36
T33	300	2DSA	1.25*
T34	600	2DSA	.50*
T38	400	2DTP	1.03*
T39	600	2DAT	.59*
T44	600	2DAT	.78*
OV1	300	2DTP	.85
OV10	300	2DSA	.74
U1	300	2DTP	.82
U6	300	2DTP	.82
X26	250	2DTP	.55

*Estimated

TABLE IV

NAVAIRTESTCEN

IMPROVEMENT AND MODERNIZATION
PROJECT (IMP) REQUIREMENTS ($1000)

	Fiscal Year			
IMP	79	80	81	82
A-1	490	810	840	915
A-2	1076	500	500	500
A-3	265	600	490	600
A-4	500	550	150	--
A-5,6	--	1000	400	1800
A-7	--	400	800	--
A-10	490	386	314	320
A-13	300	75	--	--
A-14	25	435	330	--
B-1	--	938	1110	1130
B-2	77	5	10	20
B-3	165	115	125	155
C-1	60	--	--	--
C-2	218	85	285	285
C-3	100	100	100	100
C-4	142	--	--	--
C-5	174	84	84	78
C-6	35	28	15	45
D-1	--	50	50	50
D-2	89	90	90	90
E-1	--	26	26	26
E-3	--	29	29	10
E-3	--	20	10	10
E-4	--	25	25	--
E-5	--	25	25	--
F-1	--	5200	5400	5500
F-2,2A	--	160	111	32
F-3	--	470	--	--

		Fiscal Year		
IMP	79	80	81	82
F-4	--	--	168	168
F-5	--	25	278	65
F-6	--	60	74	--
F-7	10	10	10	--
F-8	--	50	100	100
F-9	50	75	50	--
F-10	--	90	90	90
G-2	--	--	--	--
G-5	--	84	--	--
G-6	--	82	--	--
G-7	--	40	40	40
G-9	--	304	--	--
G-10, H-1, I-7, J-1	382	1815	1750	945
G-12	--	161	--	--
H-2	200	100	100	50
H-3	61	100	25	25
I-2	--	254	900	360
I-3	165	233	490	315
I-4	--	90	40	10
I-5	--	165	820	50
I-6	125	65	50	20
I-8	--	68	58	60
I-9	153	121	132	68
I-10	--	170	84	24
I-12	--	80	40	15
I-13	--	310	160	115
J-3	--	125	200	25
J-4	--	200	100	--
Constraint	4000	7400	10100	11500

FROM \ TO FUNCTIONAL AREA	FAP CODE	2A	2B	2C	2D	2E	2F	2G	2H	2I	2J	2K	2L	2M	2N	2Ø	2P	2Q	2R	RIF
AIR VEHICLE	2A	.3	.8	.3	—	1.5	1.5	.3	1.0	1.0	1.0	1.5	1.5	1.2	1.0	.8	.5	1.0	—	.5
MISSION SYSTEMS	2B	.8	.3	.3	—	.3	.3	.5	.5	1.0	.3	.5	.5	.7	.5	.7	.5	.5	—	.5
REM	2C	.3	.5	.2	-	.7	.5	.5	.3	1.0	1.0	.5	1.0	1.2	1.0	1.0	.8	1.0	—	.5
A/C MAINT	2D	—	—	- -	.1	—	—	—	—	—	—	—	—	.4	.5	.5	—	.5	.3	.5
EMV	2E	.5	.3	.5	—	0	.3	.5	.5	1.0	.3	.5	.5	1.0	.8	.6	.8	.6	—	.5
E AND E	2F	.5	.3	.5	—	.3	0	.5	.5	1.0	.5	.5	.5	.8	.6	.5	1.0	.5	—	.5
GSS	2G	.3	.5	.3	—	.8	.8	0	.6	1.0	.7	.8	1.0	1.0	.7	.6	1.0	.6	—	.5
ORDNANCE	2H	.3	.5	.3	—	.7	.5	.5	0	1.0	1.0	.5	1.0	.8	.5	.5	.8	.5	—	.5
CREW SYSTEMS	2I	1.0	1.0	1.0	—	1.0	1.0	1.0	1.0	.0	1.0	1.0	1.0	1.0	.8	.6	.8	.7	—	.5
EW	2J	.5	.3	.4	—	.3	.3	.5	.5	1.0	0	.5	.5	1.0	.5	.7	.8	.8	—	.5
CV SUIT	2K	.3	.5	.5	—	1.5	1.5	.3	1.0	1.0	1.0	0	1.5	1.0	1.0	.5	.5	.5	—	.5
CNI	2L	.5	.3	.5	—	.5	.5	.5	.5	1.0	.5	.5	0	1.0	.6	.7	.8	.6	—	.5
A/B INST	2M	1.5	.5	.5	1.0	1.0	.5	.5	.3	—	1.0	.5	1.0	0	.1	.1	—	.1	—	.5
RANGE	2N	1.5	.5	1.0	—	1.0	.5	.5	.5	—	.5	1.0	.5	.1	0	.1	.3	.1	—	.5
TELEM	2Ø	1.5	.5	1.0	—	1.0	.7	.7	.7	—	.7	1.0	1.0	.1	.1	0	.3	.1	—	.5
COMPUTER	2P	.5	.5	.7	—	1.0	.7	.5	.5	1.0	.5	.7	1.0	1.5	.5	.5	0	.5	—	.5
INST. LAB. SERV.	2Q	1.5	1.5	1.0	1.0	1.0	.7	.5	1.0	—	.7	1.0	1.0	.1	.1	.1	—	0	—	.5
TID	2R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0	0	.5
NEW HIRE		.5	.5	.3	.1	.5	.3	.3	.3	.5	.5	.5	.5	.3	.3	.3	.3	.3	.3	—
CONTRACTOR		.3	.3	.3	.1	.3	.3	.3	.3	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2	—

NOTE: ESTIMATE OF ADDITIONAL MAN YEARS TO ACHIEVE A ONE MAN YEAR EFFORT FOLLOWING A REALLOCATION OF ASSETS FROM ONE FACC TO ANOTHER.

TABLE V
REALLOCATION COST MATRIX
CIVILIAN PERSONNEL

TABLE VI

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
001	1	5	0.99994	NO	NO	YES	YES
002	1	3	0.89108	YES	YES	YES	NO
003	1	5	0.45629	NO	YES	YES	YES
004	1	5	0.45483	NO	YES	YES	YES
005	1	5	0.73440	YES	YES	YES	NO
006	1	2	0.81070	YES	YES	YES	YES
007	1	5	0.95115	YES	YES	YES	YES
008	1	5	0.80462	YES	YES	YES	YES
009	1	5	0.84983	YES	YES	YES	YES
010	1	3	0.90254	YES	YES	YES	YES
011	1	5	0.61631	YES	YES	YES	YES
012	1	5	0.69417	YES	YES	YES	YES
013	1	1	0.75247	YES	YES	YES	YES
014	1	5	0.45043	YES	NO	YES	YES
015	1	5	0.79396	YES	NO	YES	YES
016	1	5	0.86407	YES	YES	YES	YES
017	1	5	0.44602	YES	YES	YES	YES
018	1	5	0.44454	YES	NO	YES	YES
019	1	5	0.44896	YES	NO	YES	YES
020	1	5	0.44306	YES	YES	YES	YES
021	1	3	0.62849	YES	YES	YES	YES
022	1	5	0.43713	YES	YES	YES	YES
023	1	3	0.62486	YES	YES	YES	YES
024	1	2	0.67975	YES	YES	YES	YES

TABLE VI (Cont.)
COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
025	1	5	0.88105	YES	YES	YES	NO
026	1	2	0.68422	YES	YES	YES	NO
027	1	5	0.43266	YES	YES	YES	NO
028	4	5	0.19774	YES	YES	YES	*
031	2	5	0.62156	YES	YES	YES	*
034	1	5	0.80462	YES	NO	YES	YES
035	1	5	0.77745	YES	YES	YES	YES
036	1	5	0.86407	NO	NO	YES	YES
037	1	5	0.90438	YES	NO	YES	YES
038	1	5	0.83002	NO	NO	NO	YES
039	1	5	0.76320	NO	NO	YES	YES
040	1	5	0.95115	YES	YES	YES	YES
041	1	5	0.91336	NO	NO	NO	YES
042	1	3	0.93663	YES	YES	YES	NO
044	1	5	0.68644	YES	YES	YES	YES
045	1	5	0.90863	YES	YES	YES	YES
046	1	5	0.41004	YES	NO	YES	YES
050	1	1	0.82673	YES	YES	YES	YES
051	1	1	0.85816	YES	YES	YES	YES
052	2	5	0.58152	YES	YES	YES	YES
053	1	5	0.59893	YES	YES	YES	YES
055	1	2	0.96602	NO	NO	YES	YES
056	1	1	0.96454	NO	YES	YES	YES
057	1	5	0.99917	NO	NO	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
058	1	1	0.98075	YES	YES	YES	YES
060	1	1	0.89942	YES	YES	YES	YES
062	1	5	0.63451	NO	NO	YES	YES
068	1	1	0.89816	YES	YES	YES	YES
069	1	1	0.91739	YES	YES	YES	YES
070	1	1	0.94342	YES	YES	YES	YES
072	1	1	0.83083	YES	YES	YES	YES
074	1	1	0.83002	YES	YES	YES	YES
078	1	1	0.97128	YES	YES	YES	YES
079	1	5	0.99899	YES	YES	YES	YES
080	1	1	0.78302	YES	YES	YES	YES
082	1	2	0.97161	YES	YES	YES	YES
083	1	1	0.93360	YES	YES	YES	YES
084	1	1	0.91739	YES	YES	YES	YES
085	1	1	0.89942	YES	YES	YES	YES
086	1	1	0.88645	YES	YES	YES	YES
087	1	1	0.83327	YES	YES	YES	YES
088	1	1	0.83246	YES	YES	YES	YES
089	1	1	0.78487	YES	YES	YES	YES
090	1	1	0.78395	YES	YES	YES	YES
091	1	1	0.78302	YES	YES	YES	YES
092	1	1	0.78210	YES	YES	YES	YES
093	1	1	0.78117	YES	YES	YES	YES
095	1	1	0.94342	NO	NO	NO	YES

TABLE VI (Cont.)
COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
096	1	1	0.78024	YES	YES	YES	YES
108	1	1	0.77931	YES	YES	YES	YES
110	1	1	0.87270	YES	YES	YES	YES
111	1	2	0.82007	YES	YES	YES	YES
112	1	1	0.90561	NO	NO	YES	YES
116	1	1	0.89816	YES	YES	YES	YES
118	1	5	0.99899	YES	YES	YES	YES
119	2	5	0.97260	YES	YES	YES	NO
120	1	5	0.99886	NO	NO	YES	YES
121	1	1	0.99646	YES	YES	YES	YES
122	1	1	0.99519	YES	NO	YES	YES
123	1	1	0.96454	YES	YES	YES	YES
125	1	1	0.86187	YES	YES	YES	YES
129	1	2	0.97701	YES	YES	YES	YES
130	1	5	0.86407	YES	YES	YES	YES
131	1	5	0.80462	YES	YES	YES	YES
132	1	2	0.85891	YES	YES	YES	YES
133	1	5	0.74050	YES	YES	YES	YES
134	1	5	0.92189	NO	NO	YES	YES
135	1	5	0.89043	NO	YES	YES	YES
136	1	5	0.88911	NO	NO	YES	YES
137	1	3	0.92572	YES	YES	YES	YES
138	1	4	0.90863	YES	YES	YES	YES
139	1	3	0.85965	YES	YES	YES	YES

TABLE VI (Cont.) COMPARATIVE RESULTS							
PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
141	1	3	0.92354	YES	YES	YES	YES
143	1	1	0.88945	YES	YES	YES	YES
183	1	5	0.92022	YES	YES	YES	YES
185	1	5	0.99886	NO	NO	NO	YES
186	1	5	0.99972	NO	NO	NO	YES
188	1	5	0.99988	YES	YES	YES	YES
189	1	1	0.95246	YES	YES	YES	YES
192	1	1	0.88444	YES	YES	YES	YES
193	1	5	0.63090	YES	YES	YES	YES
196	1	1	0.87967	YES	YES	YES	YES
197	1	5	0.93713	NO	NO	NO	YES
198	1	3	0.91682	YES	YES	YES	YES
199	1	2	0.82007	YES	YES	YES	YES
201	1	1	0.97326	YES	YES	YES	YES
203	1	2	0.96265	YES	YES	YES	YES
204	1	1	0.94104	YES	YES	YES	YES
205	1	1	0.95668	YES	NO	YES	YES
206	1	1	0.95246	YES	YES	YES	YES
207	1	1	0.98340	YES	YES	YES	YES
208	1	1	0.98314	YES	NO	YES	YES
209	1	2	0.99505	YES	NO	YES	YES
212	1	3	0.99646	YES	NO	NO	YES
214	1	2	0.99692	YES	YES	YES	YES
215	1	3	0.91682	YES	YES	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
216	1	1	0.99992	YES	YES	YES	YES
217	1	1	0.98075	YES	YES	YES	YES
218	1	1	0.97485	YES	YES	YES	YES
219	1	1	0.97454	YES	YES	YES	YES
220	1	2	0.98562	NO	NO	NO	NO
222	2	2	0.90369	NO	NO	YES	NO
224	1	1	0.92839	YES	YES	YES	YES
225	1	1	0.64639	YES	YES	YES	YES
226	1	3	0.99307	YES	YES	YES	YES
227	1	1	0.99505	YES	YES	YES	YES
228	1	1	0.97161	YES	YES	YES	YES
230	1	1	0.99371	YES	YES	YES	YES
231	1	1	0.99204	YES	YES	YES	YES
232	1	5	0.99810	YES	NO	YES	YES
233	1	5	0.87551	YES	NO	YES	YES
234	1	5	0.84205	NO	NO	YES	NO
235	1	2	0.96602	YES	NO	YES	YES
236	1	2	0.98586	YES	YES	YES	YES
239	1	1	0.87621	YES	YES	YES	YES
240	1	1	0.98586	YES	YES	YES	YES
243	1	5	0.99934	YES	NO	NO	NO
247	1	2	0.88241	YES	NO	NO	YES
249	1	5	0.99952	YES	NO	NO	YES
250	1	5	0.99371	YES	NO	NO	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
251	1	5	0.99939	YES	NO	NO	YES
252	1	5	0.99356	YES	YES	YES	YES
253	1	5	0.97849	YES	YES	YES	YES
254	2	5	0.99580	YES	YES	YES	*
255	1	5	0.77745	YES	NO	YES	YES
256	2	5	0.92691	YES	YES	YES	*
257	2	3	0.87336	YES	YES	YES	YES
258	2	5	0.76024	YES	YES	YES	*
260	1	5	0.96341	YES	YES	YES	YES
261	1	5	0.94804	YES	NO	YES	YES
262	1	5	0.95203	NO	NO	YES	YES
269	1	5	0.99462	NO	NO	NO	YES
270	1	5	0.98609	NO	NO	YES	YES
272	1	2	0.99858	NO	NO	NO	YES
273	1	5	0.97326	YES	YES	YES	YES
275	1	1	0.99546	YES	YES	YES	YES
276	1	3	0.99981	YES	YES	YES	YES
277	1	2	0.99818	YES	NO	YES	YES
278	1	1	0.92299	YES	YES	YES	YES
280	1	5	0.87621	YES	YES	YES	YES
281	1	1	0.98723	YES	YES	YES	YES
282	1	5	0.99037	YES	YES	YES	YES
285	1	1	0.94804	NO	NO	NO	YES
286	1	5	0.99810	YES	NO	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
288	1	1	0.85365	YES	YES	YES	YES
289	1	1	0.84597	YES	YES	YES	YES
290	1	3	0.91682	YES	YES	YES	YES
291	1	3	0.98833	YES	YES	YES	YES
294	1	1	0.92839	YES	YES	YES	YES
295	1	2	0.98019	YES	YES	YES	YES
296	1	5	0.95460	YES	NO	NO	YES
297	1	5	0.99585	YES	NO	NO	YES
300	1	5	0.99658	YES	NO	NO	YES
301	1	5	0.95709	YES	NO	NO	YES
303	1	2	0.96602	YES	YES	YES	YES
305	1	5	0.95750	NO	NO	NO	YES
307	1	3	0.95585	YES	YES	YES	YES
310	1	1	0.98917	YES	YES	YES	YES
311	1	1	0.97326	YES	YES	YES	YES
313	1	2	0.95750	YES	NO	YES	YES
319	1	1	0.93861	YES	NO	YES	YES
322	1	1	0.93812	YES	YES	YES	YES
323	1	1	0.93613	NO	NO	YES	YES
324	1	1	0.95585	NO	NO	YES	YES
325	1	1	0.95544	YES	NO	YES	YES
327	1	1	0.95502	YES	YES	YES	YES
329	1	1	0.95460	NO	NO	YES	YES
330	1	1	0.88645	YES	YES	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
343	1	1	0.96454	YES	YES	YES	YES
344	1	2	0.97701	NO	NO	YES	NO
345	1	5	0.99810	NO	NO	YES	YES
346	1	5	0.90863	YES	YES	YES	YES
347	1	2	0.99257	YES	YES	YES	YES
348	1	5	0.93258	NO	NO	YES	YES
349	1	5	0.96071	YES	YES	YES	YES
350	1	5	0.99734	NO	NO	YES	YES
351	1	1	0.89879	YES	YES	YES	YES
352	1	5	0.95750	YES	NO	YES	YES
353	1	5	0.97610	YES	YES	YES	YES
354	1	5	0.97579	YES	YES	YES	NO
359	1	5	0.89497	NO	NO	YES	YES
361	1	1	0.99519	YES	YES	YES	YES
362	1	1	0.99505	YES	YES	YES	YES
363	1	1	0.99491	YES	YES	YES	YES
364	1	2	0.99371	YES	YES	YES	YES
365	1	1	0.99462	YES	YES	YES	NO
366	1	1	0.94342	YES	YES	YES	YES
368	1	1	0.99912	YES	YES	YES	YES
369	1	5	0.92998	NO	NO	NO	YES
375	1	1	0.98340	YES	YES	YES	YES
376	1	2	0.96992	NO	NO	YES	YES
381	1	1	0.80110	YES	YES	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
382	1	5	0.99734	NO	NO	YES	YES
383	2	5	0.718-0	NO	NO	YES	NO
384	1	1	0.94342	YES	YES	YES	YES
386	1	5	0.91336	NO	NO	YES	YES
387	1	1	0.99114	YES	YES	YES	NO
392	1	3	0.98678	YES	YES	YES	YES
393	1	1	0.99018	YES	YES	YES	YES
394	1	1	0.99076	YES	YES	YES	YES
395	1	2	0.98875	YES	YES	YES	YES
396	2	2	0.90197	YES	YES	YES	NO
397	1	2	0.93959	YES	YES	YES	YES
398	1	1	0.95027	YES	YES	YES	YES
399	1	1	0.94983	YES	YES	YES	YES
400	1	1	0.95072	YES	YES	YES	YES
401	1	1	0.95072	YES	YES	YES	YES
402	1	1	0.95115	YES	YES	YES	NO
403	1	1	0.95115	YES	YES	YES	NO
404	2	5	0.91287	NO	NO	YES	NO
407	2	5	0.90110	NO	NO	YES	NO
409	1	1	0.99519	NO	NO	YES	YES
415	1	5	0.94389	YES	NO	YES	YES
416	1	2	0.98314	YES	YES	YES	YES
417	1	2	0.93663	NO	NO	YES	YES
418	1	2	0.93762	YES	NO	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
419	1	2	0.96188	YES	YES	YES	YES
420	1	1	0.91739	YES	YES	YES	YES
422	1	5	0.99222	NO	NO	YES	YES
423	1	1	0.99635	YES	YES	YES	YES
430	1	1	0.95872	YES	YES	YES	YES
432	1	1	0.94342	YES	YES	YES	YES
436	1	1	0.97161	YES	YES	YES	YES
437	1	2	0.96602	YES	YES	YES	NO
438	1	5	0.99658	NO	NO	YES	YES
439	1	5	0.99635	YES	NO	YES	YES
440	1	5	0.96071	YES	YES	YES	YES
441	1	5	0.76224	YES	NO	YES	YES
442	1	5	0.95750	YES	NO	YES	YES
443	1	1	0.98811	YES	YES	YES	YES
447	1	1	0.99447	YES	YES	YES	YES
448	1	2	0.91394	YES	YES	YES	YES
449	1	1	0.93360	YES	NO	YES	YES
451	1	1	0.93309	YES	YES	YES	YES
452	1	1	0.96454	YES	NO	YES	YES
456	1	5	0.92078	YES	NO	YES	YES
457	1	2	0.90742	NO	YES	YES	YES
460	1	2	0.98586	NO	NO	NO	YES
463	1	1	0.98075	YES	YES	YES	YES
466	1	2	0.96188	YES	YES	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
467	2	5	0.96584	YES	YES	YES	NO
468	2	5	0.92314	YES	YES	YES	NO
469	2	5	0.90110	YES	YES	YES	NO
470	4	5	0.87963	YES	NO	YES	NO
471	1	5	0.95832	NO	NO	NO	YES
472	2	5	0.88858	YES	YES	YES	NO
473	2	5	0.90023	YES	YES	YES	NO
474	1	5	0.98609	NO	NO	YES	NO
475	1	5	0.95115	YES	YES	YES	YES
476	1	1	0.99356	YES	YES	YES	YES
477	1	5	0.45921	NO	NO	YES	YES
478	1	5	0.91336	NO	NO	NO	YES
480	2	5	0.92840	NO	NO	YES	NO
481	2	5	0.69255	YES	YES	YES	NO
483	1	3	0.95832	YES	YES	YES	YES
484	1	1	0.97790	YES	NO	YES	YES
485	1	5	0.97731	NO	NO	YES	NO
486	2	5	0.97122	YES	YES	YES	NO
487	1	1	0.98746	YES	YES	YES	YES
488	2	5	0.88950	YES	YES	YES	NO
491	1	2	0.98391	YES	YES	YES	YES
492	2	5	0.98782	YES	NO	YES	NO
493	1	5	0.97701	YES	NO	YES	NO
494	1	5	0.98609	NO	NO	YES	NO

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
496	4	5	0.00905	NO	YES	YES	NO
500	4	5	0.0	NO	NO	NO	NO
502	1	1	0.87270	YES	YES	YES	YES
503	1	1	0.70287	YES	YES	YES	YES
504	1	1	0.88645	YES	YES	YES	YES
509	1	5	0.99658	YES	NO	YES	NO
512	1	1	0.80110	YES	YES	YES	YES
513	1	5	0.78578	YES	NO	YES	NO
515	1	1	0.70287	NO	NO	YES	YES
516	1	2	0.69197	NO	NO	YES	YES
518	1	5	0.65226	YES	NO	YES	NO
519	2	5	0.0	NO	NO	NO	NO
522	1	5	0.99981	YES	NO	NO	YES
523	1	5	0.99981	YES	NO	NO	YES
524	1	2	0.95750	NO	NO	NO	NO
525	1	1	0.75444	YES	YES	YES	YES
526	1	5	0.99371	YES	YES	YES	YES
529	1	1	0.92299	NO	NO	YES	YES
530	1	3	0.93663	YES	YES	YES	YES
531	1	1	0.83489	YES	YES	YES	YES
532	1	5	0.56039	NO	NO	YES	YES
533	1	5	0.34276	YES	YES	YES	YES
534	1	5	0.33954	YES	YES	YES	YES
535	1	5	0.74851	YES	YES	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
536	1	5	0.35077	YES	YES	YES	YES
537	1	2	0.60144	YES	YES	YES	YES
538	1	2	0.92022	YES	NO	YES	YES
540	1	5	0.99692	YES	YES	YES	YES
541	1	3	0.75738	YES	YES	YES	YES
542	1	1	0.78302	YES	YES	YES	YES
543	1	1	0.75444	NO	NO	YES	YES
544	1	5	0.29367	YES	YES	YES	YES
545	1	5	0.21847	YES	YES	YES	YES
546	1	5	0.97849	YES	YES	YES	YES
547	1	5	0.56039	YES	YES	YES	YES
549	1	1	0.92839	YES	YES	YES	YES
551	1	5	0.99734	YES	YES	YES	YES
554	1	1	0.96711	YES	YES	YES	YES
559	1	5	0.45629	NO	YES	NO	NO
561	1	5	0.98917	YES	YES	YES	YES
562	1	5	0.99692	YES	YES	YES	YES
563	1	5	0.89497	NO	NO	YES	NO
564	1	5	0.56039	NO	NO	YES	YES
565	1	5	0.98263	NO	NO	YES	YES
566	1	1	0.78302	NO	NO	YES	YES
567	1	1	0.87899	YES	YES	YES	NO
568	1	1	0.87899	YES	YES	YES	YES
569	1	5	0.80462	NO	NO	NO	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
570	1	5	0.80462	YES	NO	YES	YES
571	1	5	0.80462	YES	NO	YES	YES
572	1	5	0.85365	YES	NO	NO	YES
573	1	5	0.85213	YES	YES	YES	YES
574	1	5	0.61631	NO	NO	NO	YES
575	1	5	0.99703	NO	YES	YES	NO
578	2	5	0.99999	YES	YES	YES	*
579	1	5	0.99222	YES	NO	NO	YES
580	1	5	0.94436	YES	YES	YES	YES
583	1	2	0.87899	YES	YES	YES	YES
584	1	5	0.65226	YES	YES	YES	NO
585	1	5	0.80374	YES	YES	YES	NO
586	1	5	0.80374	YES	YES	YES	NO
587	1	1	0.99447	YES	YES	YES	YES
588	4	5	0.87963	NO	NO	NO	NO
589	2	5	0.94502	YES	NO	NO	NO
591	1	2	0.98586	YES	YES	YES	YES
592	1	3	0.99774	YES	YES	YES	NO
593	3	5	0.75147	NO	NO	NO	NO
594	2	2	0.99981	NO	NO	YES	NO
595	4	5	0.87963	NO	NO	NO	NO
597	2	5	0.90110	NO	NO	NO	NO
598	2	5	0.87726	NO	NO	YES	NO
577	1	2	0.99076	YES	NO	NO	NO

TABLE VI (Cont.)
COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
599	1	2	0.98701	YES	YES	YES	NO
602	1	1	0.99323	YES	YES	YES	YES
605	1	1	0.99323	YES	NO	YES	YES
606	1	1	0.98586	YES	YES	YES	YES
607	1	1	0.98562	YES	YES	YES	YES
608	1	1	0.98811	YES	YES	YES	YES
609	1	1	0.98790	YES	YES	YES	YES
610	1	1	0.98768	YES	YES	YES	YES
611	1	5	0.99843	YES	NO	NO	YES
614	1	5	0.99917	NO	NO	NO	YES
615	1	1	0.99519	YES	YES	YES	NO
616	1	1	0.99519	YES	YES	YES	YES
617	1	1	0.98075	YES	YES	YES	NO
618	1	1	0.98075	YES	YES	YES	YES
619	1	1	0.99519	YES	YES	YES	NO
621	1	1	0.99912	YES	YES	YES	YES
623	1	1	0.98811	YES	NO	YES	YES
624	1	2	0.94295	YES	YES	YES	NO
625	1	5	0.98609	YES	YES	YES	YES
626	1	1	0.99018	YES	YES	YES	YES
628	1	2	0.99818	NO	NO	NO	NO
629	1	1	0.99754	YES	YES	YES	NO
630	1	5	0.80462	YES	YES	YES	YES
631	1	5	0.80374	YES	YES	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
633	1	5	0.96853	YES	YES	YES	YES
634	1	5	0.95115	NO	NO	YES	YES
635	1	1	0.91042	YES	YES	YES	YES
637	1	5	0.80110	YES	YES	YES	YES
638	1	1	0.99843	NO	NO	YES	YES
639	1	5	0.80110	YES	YES	YES	YES
640	1	2	0.96782	NO	NO	YES	NO
641	3	5	0.92794	YES	YES	YES	NO
642	2	5	0.95719	NO	NO	YES	NO
643	2	5	0.0	NO	NO	NO	YES
644	1	1	0.99880	NO	YES	NO	YES
645	2	2	0.99997	NO	NO	YES	NO
646	2	2	0.99648	YES	YES	YES	*
647	1	3	0.98102	YES	YES	YES	YES
648	2	5	0.69255	NO	NO	YES	NO
649	3	5	0.95489	YES	YES	YES	NO
650	2	2	0.98283	YES	YES	YES	NO
651	1	5	0.97701	NO	NO	YES	NO
652	3	5	0.87048	YES	YES	YES	NO
653	2	2	0.96785	YES	YES	YES	NO
654	3	5	0.90038	YES	YES	YES	NO
657	1	1	0.99754	NO	NO	YES	YES
658	2	3	0.99196	YES	YES	YES	NO
661	1	1	0.99851	YES	YES	YES	YES

TABLE VI (Cont.)
COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
663	1	5	0.97849	YES	YES	YES	NO
664	1	2	0.85516	YES	YES	YES	NO
665	1	2	0.99433	NO	NO	YES	NO
666	1	1	0.99912	YES	YES	YES	YES
667	1	2	0.81070	YES	YES	YES	NO
668	1	1	0.87968	YES	YES	YES	NO
669	1	5	0.45629	YES	YES	YES	NO
670	1	1	0.98210	YES	YES	YES	YES
671	1	1	0.98465	YES	NO	YES	YES
672	3	3	0.57884	YES	YES	YES	YES
674	1	1	0.99912	NO	YES	YES	NO
675	1	2	0.99858	YES	YES	YES	NO
676	1	2	0.97701	NO	NO	YES	YES
678	1	1	0.99290	YES	YES	YES	YES
679	1	5	0.21847	YES	YES	YES	YES
681	1	5	0.88036	YES	YES	YES	NO
682	1	1	0.96071	YES	YES	YES	NO
683	2	4	0.43491	YES	YES	YES	NO
692	1	1	0.99519	YES	YES	YES	NO
693	1	1	0.96454	NO	YES	YES	YES
714	1	1	0.98340	YES	YES	YES	NO
715	2	3	0.96735	YES	YES	YES	NO
716	1	2	0.81070	YES	YES	YES	YES
718	1	1	0.99204	NO	NO	YES	NO

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
719	1	1	0.99371	YES	YES	YES	YES
725	1	5	0.97849	NO	NO	YES	YES
726	1	1	0.99801	YES	YES	YES	YES
728	1	1	0.98609	YES	YES	YES	YES
730	5	5	0.0	NO	NO	NO	NO
731	4	5	0.84253	YES	YES	YES	*
732	3	3	0.77724	YES	YES	YES	*
733	3	3	0.70219	YES	YES	YES	*
734	1	1	0.93861	NO	NO	YES	NO
735	1	1	0.96071	YES	YES	YES	NO
737	1	1	0.98655	YES	YES	YES	NO
738	1	2	0.96188	YES	YES	YES	YES
739	1	1	0.98811	YES	YES	YES	YES
740	1	1	0.99519	YES	YES	YES	NO
741	1	5	0.34276	YES	YES	YES	YES
750	1	5	0.21847	YES	YES	YES	YES
757	1	2	0.96188	YES	YES	YES	YES
758	1	5	0.97610	YES	YES	YES	NO
759	4	5	0.93081	YES	YES	YES	NO
761	4	5	0.95062	YES	YES	YES	NO
762	2	5	0.98355	NO	NO	YES	NO
763	1	1	0.99371	YES	NO	YES	YES
764	1	1	0.99356	YES	YES	YES	YES
767	1	1	0.98075	YES	NO	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
768	1	1	0.97161	YES	YES	YES	YES
770	1	2	0.94804	YES	YES	YES	YES
771	1	2	0.98938	YES	YES	YES	YES
773	1	1	0.92839	YES	YES	YES	NO
776	1	5	0.97293	YES	YES	YES	NO
778	1	1	0.99204	YES	YES	YES	YES
779	1	1	0.99187	YES	YES	YES	YES
780	1	1	0.85816	YES	YES	YES	YES
781	1	1	0.85742	YES	YES	YES	YES
782	1	1	0.85667	YES	YES	YES	YES
783	1	1	0.81838	YES	YES	YES	YES
784	1	1	0.81754	YES	YES	YES	YES
786	2	5	0.30824	NO	YES	YES	NO
787	1	5	0.79125	YES	NO	YES	YES
788	1	1	0.70287	YES	YES	YES	NO
790	1	1	0.84127	YES	YES	YES	YES
791	1	1	0.72409	YES	YES	YES	NO
803	1	1	0.87968	YES	YES	YES	NO
805	1	1	0.77369	YES	YES	YES	NO
808	1	1	0.68087	YES	YES	YES	YES
812	1	1	0.98586	YES	YES	YES	YES
816	1	1	0.87968	YES	YES	YES	YES
817	1	1	0.97161	YES	YES	YES	YES
830	1	1	0.99646	YES	YES	YES	YES

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
831	1	1	0.99635	YES	YES	YES	YES
842	2	5	0.69255	YES	YES	YES	*
843	2	5	0.93767	YES	YES	YES	*
844	3	5	0.0	YES	YES	NO	*
845	4	5	0.87963	YES	YES	YES	*
846	4	5	0.86170	YES	NO	YES	*
847	4	5	0.84253	YES	YES	YES	*
848	4	5	0.40560	YES	YES	YES	*
849	3	5	0.63074	YES	YES	YES	*
850	3	5	0.62714	YES	YES	YES	*
851	1	3	0.98102	YES	NO	NO	YES
852	2	5	0.99696	YES	YES	YES	*
854	1	1	0.96454	YES	YES	YES	YES
855	1	1	0.98075	YES	YES	YES	YES
856	1	1	0.98047	YES	YES	YES	YES
857	1	1	0.80110	YES	YES	YES	YES
858	1	5	0.99952	NO	YES	YES	YES
860	1	5	0.99948	NO	NO	NO	YES
861	1	5	0.99939	NO	NO	YES	YES
862	2	2	0.97740	YES	YES	YES	NO
863	1	2	0.90742	YES	YES	YES	YES
864	1	2	0.99983	YES	YES	YES	YES
866	1	5	0.99934	YES	NO	NO	YES
868	1	3	0.99982	YES	YES	YES	YES

TABLE VI (Cont.)
COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
869	1	2	0.79125	YES	YES	YES	YES
870	1	1	0.81838	YES	YES	YES	YES
871	1	2	0.99714	YES	YES	YES	NO
872	1	5	0.96888	YES	YES	YES	NO
873	1	5	0.96818	YES	NO	YES	NO
874	1	1	0.97060	YES	YES	YES	NO
875	1	2	0.96417	YES	YES	YES	NO
876	1	1	0.96454	YES	YES	YES	NO
878	1	1	0.99939	YES	YES	YES	YES
879	1	1	0.99934	YES	YES	YES	YES
880	1	1	0.99928	YES	NO	YES	YES
881	1	1	0.99923	YES	NO	YES	NO
882	1	1	0.99934	YES	YES	YES	YES
884	1	1	0.99934	YES	YES	YES	YES
885	1	1	0.98075	YES	YES	YES	YES
886	1	1	0.99934	YES	YES	YES	YES
888	1	1	0.97485	YES	YES	YES	YES
889	1	1	0.99114	YES	YES	YES	YES
890	1	1	0.99095	YES	YES	YES	YES
891	1	1	0.89625	YES	YES	YES	YES
892	1	1	0.98019	YES	YES	YES	YES
893	2	3	0.99951	YES	YES	YES	NO
894	2	2	0.99524	YES	YES	YES	NO
895	2	2	0.99068	YES	YES	YES	NO

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
896	1	1	0.97640	YES	YES	YES	YES
897	1	1	0.75444	YES	YES	YES	YES
898	1	1	0.70287	YES	YES	YES	YES
899	1	5	0.73440	YES	YES	YES	YES
900	1	1	0.87899	YES	YES	YES	YES
901	1	5	0.73133	YES	YES	YES	NO
902	1	2	0.76030	YES	YES	YES	NO
903	1	5	0.55776	YES	YES	YES	NO
904	1	1	0.79932	YES	YES	YES	NO
905	1	5	0.63451	YES	YES	YES	NO
906	1	5	0.63331	YES	YES	YES	YES
907	1	1	0.99519	YES	YES	YES	YES
908	1	1	0.97579	YES	YES	YES	YES
909	1	1	0.96071	YES	YES	YES	YES
910	2	5	0.99968	YES	YES	YES	*
912	1	3	0.94200	YES	YES	YES	YES
913	1	1	0.92839	YES	YES	YES	YES
914	1	2	0.96992	YES	YES	YES	YES
915	1	1	0.94342	YES	YES	YES	YES
916	1	2	0.93102	YES	YES	YES	YES
917	1	3	0.95332	YES	NO	YES	YES
918	1	2	0.79125	YES	NO	YES	YES
919	1	3	0.95289	YES	NO	YES	YES
920	1	1	0.96746	YES	YES	YES	NO

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
921	1	1	0.98811	YES	YES	YES	YES
922	1	3	0.97935	YES	YES	YES	NO
923	1	1	0.94576	YES	YES	YES	YES
924	1	1	0.97228	YES	NO	YES	YES
925	1	5	0.08152	YES	YES	YES	YES
926	1	5	0.02364	YES	YES	YES	YES
927	1	5	0.02169	YES	YES	YES	YES
928	1	5	0.01776	YES	YES	YES	YES
929	1	5	0.01579	YES	YES	YES	NO
930	1	5	0.01186	YES	YES	YES	YES
932	1	5	0.00989	YES	YES	YES	YES
934	1	5	0.00594	YES	YES	YES	YES
939	1	5	0.00396	YES	YES	YES	YES
940	1	5	0.0	NO	NO	NO	YES
942	1	5	0.32984	YES	YES	YES	YES
945	1	5	0.08152	YES	YES	YES	YES
A1	-	-	-	-	NO	YES	YES
A2	-	-	-	-	YES	YES	YES
A3	-	-	-	-	NO	YES	YES
A4	-	-	-	-	NO	NO	NO
A5	-	-	-	-	NO	NO	NO
A6	-	-	-	-	NO	NO	NO
A7	-	-	-	-	NO	NO	NO
A10	-	-	-	-	NO	NO	NO

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
A13	-	-	-	-	NO	NO	NO
A14	-	-	-	-	NO	NO	NO
B1	-	-	-	-	NO	NO	NO
B2	-	-	-	-	NO	NO	NO
B3	-	-	-	-	NO	NO	NO
C1	-	-	-	-	NO	NO	NO
C2	-	-	-	-	NO	NO	NO
C3	-	-	-	-	NO	NO	NO
C4	-	-	-	-	NO	YES	YES
C5	-	-	-	-	NO	NO	NO
C6	-	-	-	-	NO	NO	NO
D1	-	-	-	-	NO	NO	NO
D2	-	-	-	-	NO	NO	NO
E1	-	-	-	-	YES	YES	YES
E2	-	-	-	-	YES	YES	YES
E3	-	-	-	-	YES	YES	YES
E4	-	-	-	-	YES	YES	YES
E5	-	-	-	-	NO	NO	NO
F1	-	-	-	-	NO	NO	YES
F2	-	-	-	-	NO	NO	NO
F2A	-	-	-	-	NO	NO	NO
F3	-	-	-	-	YES	YES	YES
F4	-	-	-	-	NO	NO	NO
F5	-	-	-	-	NO	NO	NO

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
F6	-	-	-	-	NO	NO	NO
F7	-	-	-	-	NO	NO	NO
F8	-	-	-	-	NO	NO	NO
F9	-	-	-	-	NO	NO	NO
F10	-	-	-	-	NO	NO	NO
G2	-	-	-	-	YES	YES	YES
G5	-	-	-	-	NO	NO	YES
G6	-	-	-	-	NO	NO	NO
G7	-	-	-	-	NO	NO	NO
G9	-	-	-	-	NO	NO	NO
G10	-	-	-	-	NO	NO	NO
H1	-	-	-	-	YES	YES	YES
I7	-	-	-	-	NO	NO	YES
J1	-	-	-	-	YES	YES	YES
G12	-	-	-	-	NO	NO	NO
H2	-	-	-	-	YES	YES	YES
H3	-	-	-	-	YES	YES	YES
I2	-	-	-	-	YES	YES	YES
I3	-	-	-	-	YES	YES	YES
I4	-	-	-	-	YES	YES	YES
I5	-	-	-	-	YES	YES	YES
I6	-	-	-	-	YES	YES	YES
I8	-	-	-	-	YES	YES	YES
I9	-	-	-	-	NO	NO	NO

TABLE VI (Cont.)

COMPARATIVE RESULTS

PROJECT NUMBER	START YEAR	END YEAR	BENEFIT	MODEL I	MODEL 2	MODEL 3	PRESENT METHOD
I10	-	-	-	-	NO	NO	NO
I12	-	-	-	-	NO	NO	NO
I13	-	-	-	-	NO	NO	NO
J3	-	-	-	-	NO	NO	NO
J4	-	-	-	-	YES	YES	YES

* No decision was made - when this thesis was completed - for these projects which do not start at year 1.

TABLE VII

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2ASA	2ARW	1	0.20	-
2ATP	2AAT	1	3.33	-
2ATP	2ARW	1	5.67	5.90
2ATP	2BAT	1	-	5.30
2ATP	2CAT	1	-	2.80
2BSA	2BAT	1	13.00	-
2BSY	2ISY	1	9.30	-
2BTP	2CAT	1	2.00	-
2BTP	2ARW	1	-	3.00
2CRW	2AAT	1	2.78	-
2CRW	2CSY	1	0.12	-
2CSA	2ARW	1	7.23	-
2CSA	2CAT	1	3.97	-
2CSA	2BAT	1	-	6.80
2DAT	2MTS	1	6.39	-
2DAT	2NRA	1	10.31	-
2DRW	2MTS	1	3.30	-
2DRW	2JSA	1	-	4.40
2DSA	2MTS	1	25.95	-
2DSA	2ØTS	1	10.65	-
2DSA	2ASA	1	-	8.12
2DTP	2NRA	1	11.00	-

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2DTP	2BAT	1	-	19.20
2DTP	2QTS	1	-	0.10
2ESY	2BAT	1	5.81	-
2ESY	2ISY	1	0.75	-
2ESY	2JSA	1	7.54	-
2FSY	2BAT	1	16.30	-
2MTS	2BAT	1	8.08	-
2MTS	2BRW	1	5.10	-
2MTS	2CAT	1	6.08	-
2MTS	2HSY	1	17.34	-
2NRA	2LSY	1	16.35	-
2KSA	2ARW	1	9.43	-
2PCS	2ISY	1	1.55	-
2QTS	2GSY	1	3.36	-
2QTS	2NRA	1	10.12	-
2RTC	2QTS	1	5.25	-
2RTC	2ESY	1	-	0.30
2RTC	2FSY	1	-	0.10
2RTC	2KSA	1	-	3.60
2RTC	2LSY	1	-	0.10
2SBS	2BRW	1	-	3.80
2SBS	2BSA	1	-	0.10

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2SBS	2GSY	1	-	3.71
2SBS	2HSY	1	-	4.30
2SBS	2ISY	1	-	1.00
	TOTAL	1	228.26	72.63
2ATP	2AAT	2	2.59	-
2ATP	2ARW	2	0.13	1.0
2ATP	2ASA	2	1.95	-
2ATP	2GSY	2	4.33	-
2ATP	2BAT	2	-	9.30
2ATP	2KSA	2	-	2.20
2ATP	2QTS	2	-	0.10
2BSA	2BAT	2	2.49	-
2BSA	2BRW	2	1.69	-
2BSA	2JSA	2	11.18	-
2BSA	2HSY	2	-	3.50
2BSY	2BAT	2	6.87	-
2BSY	2CAT	2	2.93	-
2BSY	2HSY	2	-	1.80
2CRW	2CAT	2	0.10	-
2CSA	2CAT	2	12.10	-

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2CSA	2FSY	2	-	0.10
2CSA	2ISY	2	-	0.80
2CSY	2CAT	2	0.10	-
2DAT	2DSY	2	0.22	-
2DRW	2CAT	2	-	5.10
2DTP	2ASA	2	-	6.72
2DTP	2JSA	2	-	5.90
2FSY	2LSY	2	11.55	-
2KSA	2AAT	2	5.34	-
2MTS	2HSY	2	5.64	-
2MTS	2NRA	2	5.36	-
2MTS	2ØTS	2	0.44	-
2PCS	2ISY	2	5.60	-
2QTS	2NRA	2	8.34	-
2RTC	2AAT	2	-	10.30
2RTC	2GSY	2	-	3.11
2SBS	2BAT	2	-	17.10
2SBS	2BRW	2	-	4.30
2SBS	2HSY	2	-	8.50
	TOTAL	2	88.95	79.83

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2ARW	2BAT	3	-	0.50
2ASA	2AAT	3	3.12	-
2ASA	2CRW	3	0.13	-
2ASA	2GSY	3	1.65	-
2ATP	2ARW	3	1.70	-
2ATP	2CAT	3	2.49	-
2ATP	2GSY	3	5.81	-
2ATP	2ASA	3	-	2.30
2ATP	2BAT	3	-	11.50
2ATP	2FSY	3	-	0.10
2ATP	2QTS	3	-	0.10
2BSA	2BAT	3	4.55	-
2BSA	2BRW	3	2.73	-
2BSA	2LSY	3	3.45	-
2CSA	2CAT	3	13.20	-
2CSA	2BRW	3	-	1.70
2CSY	2CAT	3	0.10	-
2DAT	2DSY	3	0.22	-
2DRW	2GSY	3	-	2.51
2DRW	2JSA	3	-	1.80
2DRW	2KSA	3	-	1.80
2DSA	2AAT	3	-	11.70

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2DSA	2CAT	3	-	8.00
2HSY	2ARW	3	3.30	-
2JSA	2LSY	3	5.10	-
2KSA	2ARW	3	1.76	-
2QTS	2NRA	3	9.02	-
2QTS	2ØTS	3	6.38	-
2RTC	2BAT	3	-	11.60
2SBS	2DTP	3	-	4.54
2SBS	2HSY	3	-	6.90
2SBS	2ISY	3	-	0.20
	TOTAL	3	64.71	65.25
2ASA	2ARW	4	6.40	-
2ATP	2AAT	4	4.42	-
2ATP	2GSY	4	0.24	3.21
2ATP	2BAT	4	-	10.79
2BRW	2BAT	4	-	0.70
2BSA	2BAT	4	10.10	2.60
2BSY	2BAT	4	-	2.00
2BTP	2LSY	4	1.40	-
2BTP	2BAT	4	-	3.00

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2CRW	2ARW	4	1.27	-
2CRW	2CAT	4	0.83	-
2CRW	2BAT	4	-	1.50
2CSA	2CAT	4	12.01	-
2DAT	2DSY	4	0.11	-
2DAT	2BAT	4	-	3.81
2DRW	2QTS	4	-	0.10
2DSA	2AAT	4	-	13.90
2FSY	2BRW	4	0.65	-
2FSY	2LSY	4	19.15	-
2ISY	2HSY	4	-	1.40
2JSA	2BAT	4	4.46	-
2KSA	2GSY	4	11.90	-
2QTS	2NRA	4	3.85	-
2QTS	2ØTS	4	2.20	-
2RTC	2BAT	4	-	10.40
2RTC	2CAT	4	-	8.50
2SBS	2ARW	4	-	2.10
2SBS	2ASA	4	-	1.00
2SBS	2DTP	4	-	10.62
2SBS	2FSY	4	-	0.10
2SBS	2JSA	4	-	4.60

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2SBS	2KSA	4	-	1.80
2SBS	2LSY	4	-	0.40
	TOTAL	4	78.99	82.53
2ATP	2AAT	5	7.80	-
2ATP	2GSY	5	2.20	4.01
2ATP	2CAT	5	-	5.54
2ATP	2DAT	5	-	2.71
2ATP	2DTP	5	-	1.43
2ATP	2LSY	5	-	0.20
2ATP	2QTS	5	-	0.10
2BRW	2BAT	5	1.10	-
2BRW	2DTP	5	-	0.90
2BSA	2DTP	5	-	3.70
2BSY	2DAT	5	-	2.00
2CRW	2CAT	5	2.30	-
2CSA	2CAT	5	12.26	0.66
2CSA	2JSA	5	-	5.34
2CSY	2CAT	5	0.20	-
2DRW	2DSY	5	0.11	-
2DRW	2BAT	5	-	23.64

TABLE VII (Cont.)

MODEL-3. REALLOCATION OF PERSONNEL, IN MAN YEARS, FOR OPTIMAL PLANNING SOLUTION

FROM FACC	TO FACC	YEAR	CIVILIAN	MILITARY
2DSA	2AAT	5	-	19.00
2ESY	2BAT	5	16.31	-
2FSY	2BAT	5	4.30	-
2FSY	2LSY	5	15.30	-
2HSY	2ASA	5	-	1.80
2ISY	2CAT	5	-	3.80
2KSA	2GSY	5	12.80	-
2MTS	2NRA	5	1.43	-
2MTS	2ØTS	5	0.99	-
2RTC	2ARW	5	-	0.50
2RTC	2FSY	5	-	0.10
2SBS	2BAT	5	-	16.76
2SBS	2JSA	5	-	3.66
	TOTAL	5	77.10	95.85
	GRAND TOTAL	1 through 5	538.01	396.09

```
************************************************************************
*                                                                      *
*                            PROGRAM BEN                               *
*                                                                      *
*          PURPOSE : TO CALCULATE THE PROJECT BENEFITS                 *
*                                                                      *
*       PROGRAMMER : CHRISTOS E. MAVRIKAS                              *
*                                                                      *
*             DATE : OCTOBER 1978                                      *
*                                                                      *
************************************************************************
      DIMENSION NPRTS(6), NPRMAX(5)                                     BEN00010
C
C        PART 1
C
      DO 500 J=1,865                                                    BEN00020
      READ(1,300) (NPRTS(I),I=1,6)                                      BEN00030
300   FORMAT(6X,I4,5I10)                                                BEN00040
      SUM=0.0                                                           BEN00050
      KSTART=0                                                          BEN00060
      KEND=0                                                            BEN00070
      DO 50 K=1,5                                                       BEN00080
16    IF(KSTART.GT.0) GO TO 20                                          BEN00090
      IF(NPRTS(K+1).LE.0) GO TO 50                                      BEN00100
      KSTART=K                                                          BEN00110
      IF(K.EQ.5) KEND=5                                                 BEN00120
      GO TO 50                                                          BEN00130
20    IF(NPRTS(K+1).LE.0) GO TO 40                                      BEN00140
      IF(K.EQ.5) KEND=5                                                 BEN00150
      GO TO 50                                                          BEN00160
40    KEND=K-1                                                          BEN00170
      GO TO 100                                                         BEN00180
50    CONTINUE                                                          BEN00190
100   IF(KSTART.GT.0) GO TO 115                                         BEN00200
      NPRIAV=0                                                          BEN00210
      GO TO 130                                                         BEN00220
115   IF(KSTART.EQ.KEND) GO TO 125                                      BEN00230
120   DO 200 L=KSTART,KEND                                              BEN00240
      SUM=SUM+NPRTS(L+1)*(1.2**(L-KSTART))                              BEN00250
200   CONTINUE                                                          BEN00260
      NPRIAV=SUM/(KEND-KSTART+1)                                        BEN00270
      GO TO 130                                                         BEN00280
125   NPRIAV=NPRTS(KSTART+1)                                            BEN00290
130   WRITE(4,400) NPRTS(1),KSTART,KEND,NPRIAV                          BEN00300
400   FORMAT(I6,3(5X,I5))                                               BEN00310
500   CONTINUE                                                          BEN00320
      REWIND 4                                                          BEN00330
C
```

```
C           PART 2
C
        DO 550 J=1,865
        READ(4,400) JOB,KSTART,KEND,NPRIAV
        IF(J.GT.1) GO TO 530
        DO 520 K=1,5
        NPRMAX(K)=0
520     CONTINUE
530     IF(NPRIAV.GT.NPRMAX(KSTART))  NPRMAX(KSTART)=NPRIAV
550     CONTINUE
        WRITE(6,450) (NPRMAX(I),I=1,5)
450     FORMAT(10X,5I10)
        REWIND 4
C
C           PART 3
C
        DO 700 J=1,365
        READ(4,400) JOB,KSTART,KEND,NPRIAV
        IF(KSTART.EQ.0) GO TO 610
        RATIO=(FLOAT(NPRIAV)/FLOAT(NPRMAX(KSTART)))**2
        BENEF=1.0-RATIO
        GO TO 620
610     BENEF=0.0
620     WRITE(2,650) JOB,KSTART,KEND,BENEF
650     FORMAT(1X,I6,2(5X,I5),5X,F10.3)
700     CONTINUE
        STOP
        END
SAMPLE OF FILE  1  (  INPUT  FILE   :PROJECT PRIORITIES )
    PP0001        10          5          5          5          5
    PP0002       275        275        275
    PP0003       500        500        500        500        500
    PP0004       501        501        501        501        501
    PP0005       350        350        350        350        350
..............................................................
SAMPLE OF FILE  4  (INTERMEDIATE FILE : AV. DISC. PRIORITIES)
      1           1          5          8
      2           1          3        333
      3           1          5        744
      4           1          5        745
      5           1          5        520
..........................................
SAMPLE OF FILE  2  (OUTPUT FILE : PROJECT BENEFITS )
      1           1          5     0.99993718
      2           1          3     0.89108044
      3           1          5     0.45629483
      4           1          5     0.45483220
      5           1          5     0.73440230
```

```
***********************************************************************
*                                                                     *
*                          PROGRAM REFMT                              *
*                                                                     *
*            PURPOSE : EXTRACT DATA FRCM TAPE                         *
*                                                                     *
*         PROGRAMMER : KRISTINA L. BUTLER                             *
*                                                                     *
*               DATE : SEPTEMBER 1978                                 *
*                                                                     *
***********************************************************************
//REFMT     JOB  (0179,0005,0141),'K L BUTLER',TIME=2
//REFMT  EXEC  PLIXCLG,REGION=180K
//PLI.SYSIN  DD  *

 /*----------*/
 /*  PART 1  */
 /*----------*/

 REFMT : PROC OPTIONS(MAIN) REORDER ;

 DCL INFL FILE RECORD SEQL INPUT ENV(
          F CONSECUTIVE TOTAL) ,

     OUTFL FILE RECORD SEQL BUF OUTPUT ENV(
          VBS CONSECUTIVE RECSIZE(2624) ) ,

     SYSPRINT FILE PRINT ;

 DCL IBUF CHAR(2504) BASED(PI) ,
     OBUF CHAR(2620) BASED(PO) ;

 DCL (PA, PF, PI, PO, PS) POINTER STATIC ;

 DCL 1 OREC STATIC ,
     2 ORECID FIXED BIN(31) ,
     2 CRELIMP(4) CHAR(4) ,
     2 CBLK2_CC(20) CHAR(2) ,
     2 CIV(20,8) REAL FLOAT(6) ,
     2 MIL(20,8) REAL FLOAT(6) ,
     2 CON(20,8) REAL FLOAT(6) ,
     2 AC_TYPE(4,8) CHAR(4) ,
     2 CBLK3_HRS(4,8) REAL FLOAT(6) ,
     2 OBLK4_COST(8,8) REAL FLOAT(6) ,
     2 CBLK5_COST(4,8) REAL FLOAT(6) ;

 DCL (ADDR, BINARY, FLOAT) BUILTIN ;
```

```
DCL 1 IREC BASED(PI) ,
    2 RECID    PIC'999999' ,
    2 SHRTITL  CHAR(25) ,
    2 AIRTASK  CHAR(26) ,
    2 WU       CHAR(12) ,
    2 JO       CHAR( 9) ,
    2 APPN     CHAR( 6) ,
    2 PE_SUBH  CHAR( 6) ,
    2 PRCSTNO  CHAR( 8) ,
    2 PROJ_OF  CHAR(20) ,
    2 F_SUBCC  CHAR( 4) ,
    2 SPONSOR  CHAR(10) ,
    2 FRG_MGR  CHAR( 6) ,
    2 COG_ENG  CHAR(30) ,
    2 ANO_CD   CHAR( 1) ,
    2 CN_CD    CHAR( 1) ,
    2 PSD      CHAR( 5) ,
    2 PCD      CHAR( 5) ,

    2 RELIMP(4) CHAR(4) ,

    2 BLK2(20) ,
     3 BLK2_CC CHAR(2) ,
     3 BLK2_TYPEM(3) ,
      4 MY_FY(8) PIC'99V9' ,

    2 BLK3(4) ,
     3 BLK3_TYPFH(8) ,
      4 BLK3_TYPE CHAR(5) ,
      4 BLK3_HRS  PIC'99999' ,

    2 BLK4(8) ,
     3 BLK4_COST(8) PIC'9999V9' ,

    2 BLK5(4) ,
     3 BLK5_ACT   CHAR(5) ,
     3 BLK5_PUR   CHAR(2) ,
     3 BLK5_COST(8) PIC'9999V9' ;

DCL (INP, KNT, I, IX, J, K)
        FIXED BIN(31) STATIC INIT(0B) ;

DCL INAC(5) CHAR(1) BASED(PA) ,
    OCH5 CHAR(5) STATIC ,
    OTAC(5) CHAR(1) DEF OCH5 ;

DCL CHAR5 CHAR(5) STATIC ,
```

```
    CHAR4 CHAR(4) DEF CHAR5 POS(1) ;

DCL BLNK CHAR(1) STATIC INIT(' ') ,
    DASH CHAR(1) STATIC INIT('-') ;

    ON ENDFILE(INFL) GO TO WRAP_UP ;

    OPEN FILE(INFL) ,
         FILE(OUTFL) ,
         FILE(SYSPRINT) PAGESIZE(88) LINESIZE(133) ;

    PA = ADDR(CHAR5) ;
    PO = ADDR(OREC) ;

/*----------*/
/*  PART 2  */
/*----------*/

RD :

    READ FILE(INFL) SET(PI) ;
    INP = INP + 1 ;

    ORECID = BINARY(RECID, 31) ;

/* RELIMP  */

    ORELIMP = RELIMP ;

/*----------*/
/*  PART 3  */
/*----------*/

    DO I=1 TO 20 ;

        OBLK2_CC(I) = BLK2_CC(I) ;

        DO K=1 TO 8 ;

            CIV(I,K) = MY_FY(I,1,K) ;
            MIL(I,K) = MY_FY(I,2,K) ;
            CON(I,K) = MY_FY(I,3,K) ;

        END ;  /* THE DO K=1 TO 8  */

    END ;  /* THE DO I=1 TO 20 */
```

```
/*----------*/
/*  PART 4  */
/*----------*/

    /* A/C TYPE AND HOURS  */

    DC J=1 TO 8 ;

        DO I=1 TO 4 ;

            CHAR5 = BLK3_TYPE(I,J) ;
            OBLK3_HRS(I,J) = FLOAT(BLK3_HRS(I,J), 6) ;

            OTAC(*) = BLNK ;
            IX = 0 ;

            DO K=1 TO 5 ;

                IF INAC(K) ¬= BLNK  &  INAC(K) ¬= DASH THEN DO ;
                    IX = IX + 1 ;
                    OTAC(IX) = INAC(K) ;
                END ;  /* THE IF INAC(K)_  */

            END ;  /* THE DO K=1 TO 5  */

            CHAR5 = OCH5 ;
            AC_TYPE(I,J) = CHAR4 ;

        END ;  /* THE DO I=1 TO 4  */

    ENC ;  /* THE DO J=1 TC 8  */

/*----------*/
/*  PART 5  */
/*----------*/

    DO J=1 TO 8 ;

        DO I=1 TO 8 ;
            OBLK4_COST(I,J) = FLOAT(BLK4_COST(I,J), 6) ;
        END ;  /* THE DO J=1 TO 8  */

    END ;  /* THE DO K=1 TC 8  */


/*----------*/
```

```
/*   PART 6   */
/*-----------*/

    DO J=1 TO 8 ;

        DO I=1 TC 4 ;
            OBLK5_COST(I,J) = FLOAT(BLK5_COST(I,J), 6) ;
        END ;  /* THE DO J=1 TO 8  */

    END ;  /* THE DO I=1 TO 4  */

    WRITE FILE(CUTFL) FROM(OBUF) ;
    KNT = KNT + 1 ;

    GO TO RD ;

/*-----------*/
/*   PART 7  */
/*-----------*/

WRAP_UP :

    PUT EDIT(INP, ' INPUT  RECORDS')
            (P'Z,ZZ9', A)

            (KNT, ' OUTPUT RECORDS')
            (P'Z,ZZ9', A) ;

    CLCSE FILE(INFL) ,
          FILE(OUTFL) ,
          FILE(SYSPRINT) ;

END REFMT ;
//GO.INFL   DD  UNIT=3400-3,DISP=OLD,LABEL=(2,BLP),
//              VOL=SER=M00003,DSN=CHRISTOS,
//              DCB=(RECFM=F,LRECL=2504,BLKSIZE=2504)
//GO.OUTFL DD   UNIT=3330,DISP=(NEW,KEEP),VOL=SER=DISK03,
//              DSN=S1948.KRIS.DATA2,SPACE=(TRK,247,RLSE,CONTIG),
//              DCB=(RECFM=VBS,LRECL=2620,BLKSIZE=2624)
```

```
********************************************************************
*                                                                  *
*                       PROGRAM PREP-1                             *
*                                                                  *
*       PURPOSE : TO PREPARE THE INPUT DATA FOR MODEL-1            *
*                                                                  *
*    PROGRAMMER : CHRISTOS E. MAVRIKAS                             *
*                                                                  *
*          DATE : OCTOBER 1978                                     *
*                                                                  *
********************************************************************
//PREP$$1  JOB (1948,0552,RJ74,,10),'C.MAVRIKAS',TIME=5
//RDDATA EXEC  FORTCLG
//FORT.SYSIN  DD *
      REAL*4 CIV(8,20),MIL(8,20),CON(8,20),HOURS3(8,4),COST4(8,8),
     *COST5(8,4)
      INTEGER ID,RELIMP(4),JOBN(2),COLMNS(2),MARK(2),BOUND(2),ENDAT(2)
      INTEGER*2 CC(20),DIGIT(6)
      DIMENSION COLUMN(181),ROWNAM(181),IHELP(865),
     *COLNAM(950),TEMP(5),RHSN(180),COLN1(150),COLN2(150),COLN3(150),    PRE00020
     *COLN4(150),COLN5(150),COLN6(150),COLN7(50),ROWN1(109),ROWN2(72)    PRE0003C
      DATA JOBN/'NAVA','IR  '/,COLMNS/'COLU','MNS '/,
     *MARK/''MAR','KER''/
     *,BOUND/'BOUN','DS  '/,ENDAT/'ENDA','TA  '/
      DATA DIGIT(1),DIGIT(2),DIGIT(3),DIGIT(4),DIGIT(5),DIGIT(6)/        PRE00050
     *'  ','AT','RW','SA','SY','TP'/                                     PRE00060
      DATA RCARD,TYPE1,TYPE2,NAM,RHSCAR,RHSNAM,UPWORD,BOUNAM/
     *'ROWS',' N  ',' L  ','NAME','RHS ','BRHS',' UP ','PROJ'/
C
C         PART 1
C
      DATA ROWN1 /'BENE','AAT1','ARW1','ASA1','ASY1','ATP1','BAT1',       PRE00090
     *'BRW1','BSA1','BSY1','BTP1','CAT1','CRW1','CSA1','CSY1','CTP1',    PRE00100
     *'DAT1','DRW1','DSA1','DSY1','DTP1','ESY1','FSY1','GSY1','HSY1',    PRE00110
     *'ISY1','JSA1','KSA1','LSY1','MTS1','NRA1','OTS1','PCS1','QTS1',    PRE00120
     *'RTC1','SBS1','T--1',                                              PRE00130
     *'AAT2','ARW2','ASA2','ASY2','ATP2','BAT2','BRW2','BSA2','BSY2',    PRE00140
     *'BTP2','CAT2','CRW2','CSA2','CSY2','CTP2','DAT2','DRW2','DSA2',    PRE0015C
     *'DSY2','DTP2','ESY2','FSY2','GSY2','HSY2','ISY2','JSA2','KSA2',    PRE00160
     *'LSY2','MTS2','NRA2','OTS2','PCS2','QTS2','RTC2','SBS2','T--2',    PRE00170
     *'AAT3','ARW3','ASA3','ASY3','ATP3','BAT3','BRW3','BSA3','BSY3',    PRE00180
     *'BTP3','CAT3','CRW3','CSA3','CSY3','CTP3','DAT3','DRW3','DSA3',    PRE00190
     *'DSY3','DTP3','ESY3','FSY3','GSY3','HSY3','ISY3','JSA3','KSA3',    PRE0020C
     *'LSY3','MTS3','NRA3','OTS3','PCS3','QTS3','RTC3','SBS3','T--3'/    PRE00210
      DATA ROWN2/                                                        PRE00220
     *'AAT4','ARW4','ASA4','ASY4','ATP4','BAT4','BRW4','BSA4','BSY4',    PRE0023C
     *'BTP4','CAT4','CRW4','CSA4','CSY4','CTP4','DAT4','DRW4','DSA4',    PRE00240
     *'DSY4','DTP4','ESY4','FSY4','GSY4','HSY4','ISY4','JSA4','KSA4',    PRE00250
```

```
     *'LSY4','MTS4','NRA4','OTS4','PCS4','QTS4','RTC4','SBS4','T--4',      PRE00260
     *'AAT5','ARW5','ASA5','ASY5','ATP5','BAT5','BRW5','BSA5','BSY5',      PRE00270
     *'BTP5','CAT5','CRW5','CSA5','CSY5','CTP5','DAT5','DRW5','DSA5',      PRE00280
     *'DSY5','DTP5','ESY5','FSY5','GSY5','HSY5','ISY5','JSA5','KSA5',      PRE00290
     *'LSY5','MTS5','NRA5','OTS5','PCS5','QTS5','RTC5','SBS5','T--5'/      PRE00300
C
C        PART 2
C
      DATA COLN1                                                           PRE00310
     *      /'X001','X002','X003','X004','X005','X006','X007','X008',      PRE00320
     *'X009','X010','X011','X012','X013','X014','X015','X016','X017',      PRE00330
     *'X018','X019','X020','X021','X022','X023','X024','X025','X026',      PRE00340
     *'X027','X028','X029','X030','X031','X032','X033','X034','X035',      PRE00350
     *'X036','X037','X038','X039','X040','X041','X042','X043','X044',      PRE00360
     *'X045','X046','X047','X048','X049','X050','X051','X052','X053',      PRE00370
     *'X054','X055','X056','X057','X058','X059','X060','X061','X062',      PRE00380
     *'X063','X064','X065','X066','X067','X068','X069','X070','X071',      PRE00390
     *'X072','X073','X074','X075','X076','X077','X078','X079','X080',      PRE00400
     *'X081','X082','X083','X084','X085','X086','X087','X088','X089',      PRE00410
     *'X090','X091','X092','X093','X094','X095','X096','X097','X098',      PRE00420
     *'X099','X100','X101','X102','X103','X104','X105','X106','X107',      PRE00430
     *'X108','X109','X110','X111','X112','X113','X114','X115','X116',      PRE00440
     *'X117','X118','X119','X120','X121','X122','X123','X124','X125',      PRE00450
     *'X126','X127','X128','X129','X130','X131','X132','X133','X134',      PRE00460
     *'X135','X136','X137','X138','X139','X140','X141','X142','X143',      PRE00470
     *'X144','X145','X146','X147','X148','X149','X150'/                    PRE00480
      DATA COLN2/'X151','X152',                                            PRE00490
     *'X153','X154','X155','X156','X157','X158','X159','X160','X161',      PRE00500
     *'X162','X163','X164','X165','X166','X167','X168','X169','X170',      PRE00510
     *'X171','X172','X173','X174','X175','X176','X177','X178','X179',      PRE00520
     *'X180','X181','X182','X183','X184','X185','X186','X187','X188',      PRE00530
     *'X189','X190','X191','X192','X193','X194','X195','X196','X197',      PRE00540
     *'X198','X199','X200','X201','X202','X203','X204','X205','X206',      PRE00550
     *'X207','X208','X209','X210','X211','X212','X213','X214','X215',      PRE00560
     *'X216','X217','X218','X219','X220','X221','X222','X223','X224',      PRE00570
     *'X225','X226','X227','X228','X229','X230','X231','X232','X233',      PRE00580
     *'X234','X235','X236','X237','X238','X239','X240','X241','X242',      PRE00590
     *'X243','X244','X245','X246','X247','X248','X249','X250','X251',      PRE00600
     *'X252','X253','X254','X255','X256','X257','X258','X259','X260',      PRE00610
     *'X261','X262','X263','X264','X265','X266','X267','X268','X269',      PRE00620
     *'X270','X271','X272','X273','X274','X275','X276','X277','X278',      PRE00630
     *'X279','X280','X281','X282','X283','X284','X285','X286','X287',      PRE00640
     *'X288','X289','X290','X291','X292','X293','X294','X295','X296',      PRE00650
     *'X297','X298','X299','X300'/                                         PRE00660
      DATA COLN3/'X301','X302','X303','X304','X305',                       PRE00670
     *'X306','X307','X308','X309','X310','X311','X312','X313','X314',      PRE00680
     *'X315','X316','X317','X318','X319','X320','X321','X322','X323',      PRE00690
     *'X324','X325','X326','X327','X328','X329','X330','X331','X332',      PRE00700
```

```
*'X333','X334','X335','X336','X337','X338','X339','X340','X341',   PRE00710
*'X342','X343','X344','X345','X346','X347','X348','X349','X350',   PRE00720
*'X351','X352','X353','X354','X355','X356','X357','X358','X359',   PRE00730
*'X360','X361','X362','X363','X364','X365','X366','X367','X368',   PRE00740
*'X369','X370','X371','X372','X373','X374','X375','X376','X377',   PRE00750
*'X378','X379','X380','X381','X382','X383','X384','X385','X386',   PRE00760
*'X387','X388','X389','X390','X391','X392','X393','X394','X395',   PRE00770
*'X396','X397','X398','X399','X400','X401','X402','X403','X404',   PRE00780
*'X405','X406','X407','X408','X409','X410','X411','X412','X413',   PRE00790
*'X414','X415','X416','X417','X418','X419','X420','X421','X422',   PRE00800
*'X423','X424','X425','X426','X427','X428','X429','X430','X431',   PRE00810
*'X432','X433','X434','X435','X436','X437','X438','X439','X440',   PRE00820
*'X441','X442','X443','X444','X445','X446','X447','X448','X449',   PRE00830
*'X450'/                                                           PRE00840
 DATA COLN4/'X451','X452','X453','X454','X455','X456','X457','X458'PRE00850
*,'X459','X460','X461','X462','X463','X464','X465','X466','X467',  PRE00860
*'X468','X469','X470','X471','X472','X473','X474','X475','X476',   PRE00870
*'X477','X478','X479','X480','X481','X482','X483','X484','X485',   PRE00880
*'X486','X487','X488','X489','X490','X491','X492','X493','X494',   PRE00890
*'X495','X496','X497','X498','X499','X500','X501','X502','X503',   PRE00900
*'X504','X505','X506','X507','X508','X509','X510','X511','X512',   PRE00910
*'X513','X514','X515','X516','X517','X518','X519','X520','X521',   PRE00920
*'X522','X523','X524','X525','X526','X527','X528','X529','X530',   PRE00930
*'X531','X532','X533','X534','X535','X536','X537','X538','X539',   PRE00940
*'X540','X541','X542','X543','X544','X545','X546','X547','X548',   PRE00950
*'X549','X550','X551','X552','X553','X554','X555','X556','X557',   PRE00960
*'X558','X559','X560','X561','X562','X563','X564','X565','X566',   PRE00970
*'X567','X568','X569','X570','X571','X572','X573','X574','X575',   PRE00980
*'X576','X577','X578','X579','X580','X581','X582','X583','X584',   PRE00990
*'X585','X586','X587','X588','X589','X590','X591','X592','X593',   PRE01000
*'X594','X595','X596','X597','X598','X599','X600'/                 PRE01010
 DATA COLN5/'X601','X602',                                         PRE01020
*'X603','X604','X605','X606','X607','X608','X609','X610','X611',   PRE01030
*'X612','X613','X614','X615','X616','X617','X618','X619','X620',   PRE01040
*'X621','X622','X623','X624','X625','X626','X627','X628','X629',   PRE01050
*'X630','X631','X632','X633','X634','X635','X636','X637','X638',   PRE01060
*'X639','X640','X641','X642','X643','X644','X645','X646','X647',   PRE01070
*'X648','X649','X650','X651','X652','X653','X654','X655','X656',   PRE01080
*'X657','X658','X659','X660','X661','X662','X663','X664','X665',   PRE01090
*'X666','X667','X668','X669','X670','X671','X672','X673','X674',   PRE01100
*'X675','X676','X677','X678','X679','X680','X681','X682','X683',   PRE01110
*'X684','X685','X686','X687','X688','X689','X690','X691','X692',   PRE01120
*'X693','X694','X695','X696','X697','X698','X699','X700','X701',   PRE01130
*'X702','X703','X704','X705','X706','X707','X708','X709','X710',   PRE01140
*'X711','X712','X713','X714','X715','X716','X717','X718','X719',   PRE01150
$'X720','X721','X722','X723','X724','X725','X726','X727','X728',   PRE01160
*'X729','X730','X731','X732','X733','X734','X735','X736','X737',   PRE01170
*'X738','X739','X740','X741','X742','X743','X744','X745','X746',   PRE01180
```

```
     *'X747','X748','X749','X750'/                                      PRE01190
      DATA COLN6/'X751','X752','X753','X754','X755',                    PRE01200
     *'X756','X757','X758','X759','X760','X761','X762','X763','X764',   PRE01210
     *'X765','X766','X767','X768','X769','X770','X771','X772','X773',   PRE01220
     *'X774','X775','X776','X777','X778','X779','X780','X781','X782',   PRE01230
     *'X783','X784','X785','X786','X787','X788','X789','X790','X791',   PRE01240
     *'X792','X793','X794','X795','X796','X797','X798','X799','X800',   PRE01250
     *'X801','X802','X803','X804','X805','X806','X807','X808','X809',   PRE01260
     *'X810','X811','X812','X813','X814','X815','X816','X817','X818',   PRE01270
     *'X819','X820','X821','X822','X823','X824','X825','X826','X827',   PRE01280
     *'X828','X829','X830','X831','X832','X833','X834','X835','X836',   PRE01290
     *'X837','X838','X839','X840','X841','X842','X843','X844','X845',   PRE01300
     *'X846','X847','X848','X849','X850','X851','X852','X853','X854',   PRE01310
     *'X855','X856','X857','X858','X859','X860','X861','X862','X863',   PRE01320
     *'X864','X865','X866','X867','X868','X869','X870','X871','X872',   PRE01330
     *'X873','X874','X875','X876','X877','X878','X879','X880','X881',   PRE01340
     *'X882','X883','X884','X885','X886','X887','X888','X889','X890',   PRE01350
     *'X891','X892','X893','X894','X895','X896','X897','X898','X899',   PRE01360
     *'X900'/                                                           PRE01370
      DATA COLN7/'X901','X902','X903','X904','X905','X906','X907','X908'PRE01380
     *,'X909','X910','X911','X912','X913','X914','X915','X916','X917',  PRE01390
     *'X918','X919','X920','X921','X922','X923','X924','X925','X926',   PRE01400
     *'X927','X928','X929','X930','X931','X932','X933','X934','X935',   PRE01410
     *'X936','X937','X938','X939','X940','X941','X942','X943','X944',   PRE01420
     *'X945','X946','X947','X948','X949','X950'/                        PRE01430
      EQUIVALENCE (COLNAM(1),COLN1(1)),(COLNAM(151),COLN2(1)),          PRE01440
     *(COLNAM(301),COLN3(1)),(COLNAM(451),COLN4(1)),(COLNAM(601),COLN5(1PRE01450
     *)),(COLNAM(751),COLN6(1)),(COLNAM(901),COLN7(1)),(ROWNAM(1),ROWN1(PRE01460
     *1)),(ROWNAM(110),ROWN2(1))                                        PRE01470
C
C        PART 3
C
      DO 9 J=1,865
      IHELP(J)=0
9     CONTINUE
      N=0
1     READ(3,END=500) ID,RELIMP,CC,CIV,MIL,CON,HOLRS3,COST4,COST5
      N=N+1
11    READ(2,200,END=500) JOB,KSTART,KEND,BENEF
200   FORMAT(I6,2(5X,I5),5X,F10.8)                                      PRE01500
12    IF (ID.NE.JOB) GO TO 450                                          PRE01510
      IF(KSTART.EQ.0) GO TO 1
      IHELP(N)=ID
      COLUMN(1)=BENEF                                                   PRE01530
      DO 50 I=2,181                                                     PRE01540
      COLUMN(I)=0.0                                                     PRE01550
50    CONTINUE                                                          PRE01560
C
```

```
C           PART 4
C
        DO 300 L=1,20                                                      PRE01570
        IF(CC(L).EQ.DIGIT(1)) GO TO 300                                   PRE01580
        IF(L.LE.4) GO TO 150                                               PRE01590
        DO 140 K=KSTART,KEND                                               PRE01600
        INDEX1=17+L+36*(K-1)                                               PRE01610
        INDEX2=1+K                                                         PRE01620
        COLUMN(INDEX1)=CIV(INDEX2,L)                                       PRE01630
  140   CONTINUE                                                           PRE01640
        GO TO 300                                                          PRE01650
  150   DO 270 K=KSTART,KEND                                               PRE01660
        IF(CC(L).EQ.DIGIT(6)) GO TO 240                                    PRE01670
        IF(CC(L).EQ.DIGIT(5)) GO TO 230                                    PRE01680
        IF(CC(L).EQ.DIGIT(4)) GO TO 220                                    PRE01690
        IF(CC(L).EQ.DIGIT(3)) GO TO 210                                    PRE01700
        IF(CC(L).NE.DIGIT(2)) GO TO 260                                    PRE01710
        INDEX1=2+5*(L-1)+36*(K-1)                                          PRE01720
        GO TO 250                                                          PRE01730
  210   INDEX1=3+5*(L-1)+36*(K-1)                                          PRE01740
        GO TO 250                                                          PRE01750
  220   INDEX1=4+5*(L-1)+36*(K-1)                                          PRE01760
        GO TO 250                                                          PRE01770
  230   INDEX1=5+5*(L-1)+36*(K-1)                                          PRE01780
        GO TO 250                                                          PRE01790
  240   INDEX1=6+5*(L-1)+36*(K-1)                                          PRE01800
  250   INDEX2=1+K                                                         PRE01810
        COLUMN(INDEX1)=CIV(INDEX2,L)                                       PRE01820
        GO TO 270                                                          PRE01830
  260   WRITE(6,265) ID,L,CC                                               PRE01840
  265   FORMAT(10X,25HERROR IN COST CENTER CODE 5X,5HID = ,I6,5X,4HL = ,   PRE01850
       *I2,5X,5HCC = ,A2)                                                  PRE01860
  270   CONTINUE                                                           PRE01870
  300   CONTINUE                                                           PRE01880
C
C           PART 5
C
        IF(N.GT.1) GO TO 415
        WRITE(10,400) NAM,JOBN
  400   FORMAT(A4,10X,2A4)
        WRITE(6,600)  NAM,JOBN
  600   FORMAT(1H ,A4,10X,2A4)
        WRITE(10,701) RCARD
  701   FORMAT(A4)
        WRITE(6,601) RCARD
  601   FORMAT(1H ,A4)                                                     PRE01950
        WRITE(10,702)  TYPE1,ROWNAM(1)
  702   FORMAT(2A4)
```

```
      WRITE(6,602)   TYPE1, ROWNAM(1)
602   FORMAT(1H ,A4,A4)                                                 PRE01970
      DO 412 L=1,180                                                    PRE01980
      WRITE(10,702) TYPE2, ROWNAM(L+1)
      WRITE(6,602)  TYPE2, ROWNAM(L+1)
412   CONTINUE                                                          PRE02000
      WRITE(10,702) COLMNS
      WRITE(6,610) COLMNS
610   FORMAT(1H ,2A4)
      WRITE(10,711) MARK
711   FORMAT(14X,2A4)
      WRITE(6,611) MARK
611   FORMAT(1H ,14X,2A4)
415   WRITE(10,703) COLNAM(ID),ROWNAM(1),COLUMN(1)
703   FORMAT(4X,A4,6X,A4,6X,F12.8)
      WRITE(6,603) COLNAM(ID),ROWNAM(1),COLUMN(1)
603   FORMAT(1H ,4X,A4,6X,A4,6X,F12.8)
C
C        PART 6
C
      DO 420 I=2,181
      IF(COLUMN(I).EQ.0) GO TO 420                                      PRE02020
      WRITE(10,704) COLNAM(ID), ROWNAM(I),COLUMN(I)
704   FORMAT(4X,A4,6X,A4,6X,F5.1)
      WRITE( 6,604) COLNAM(ID), ROWNAM(I),COLUMN(I)                     PRE
604   FORMAT(1H ,4X,A4,6X,A4,6X,F5.1)
420   CONTINUE                                                          PRE02050
      GO TO 1
C
C        PART 7
C
450   WRITE(6,606) ID,JOB                                               PRE02090
606   FORMAT(10X,46HID OF PRIO AND MASTER DO NOT MATCH : MASTER = ,I6,5XPRE02100
     *,7HPRIO = ,I6)                                                    PRE02110
      IF(ID.GT.JOB) GO TO 11
      DO 15 I=1,20
      IF(I.GT.1) GO TO 25
      WRITE(6,110) ID
110   FORMAT(10X,I6//)
25    WRITE(6,120) CC(I),(CIV(M,I),M=2,6)
120   FORMAT(10X,A2,5(F5.1,5X))
15    CONTINUE
      READ(3,END=500) ID,RELIMP,CC,CIV,MIL,CON,HOURS3,COST4,COST5
      GO TO 12
500   CONTINUE                                                          PRE02120
C
C        PART 8
C
```

```
      WRITE(10,711) MARK
      WRITE(6,611 ) MARK
      WRITE(10,701) RHSCAR
      WRITE(6,605)  RHSCAR
605   FCRMAT(1H ,A4)                                                    PRE02070
      DO 700 L=1,36                                                     PRE02130
      REAC(5,607)   (TEMP(I),I=1,5)                                     PRE02140
607   FCRMAT(10X,5F10.1)                                                PRE0215C
      DO 650 K=1,5                                                      PRE02160
      INDEX= L+36*(K-1)                                                 PRE02170
      RHSN(INDEX)=TEMP(K)                                               PRE02180
650   CONTINUE                                                          PRE02190
700   CCNTINUE                                                          PREC220C
      DO 800 K=1,180                                                    PRE02210
      WRITE(10,704) RHSNAM,ROWNAM(K+1),RHSN(K)
      WRITE(6 ,608)  RHSNAM,ROWNAM(K+1),RHSN(K )
608      FORMAT(1H ,4X,A4,6X,A4,6X,F5.1)                                PRE02230
800   CCNTINUE                                                          PRE02240
C
C        PART 9
C
      WRITE(10,702) BOUND
      WRITE(6,610) BOUND
      UPBND=1 .0
      DC 900 I=1,N
      IF(IHELP(I).EQ.0) GO TO 900
      WRITE(10,709) UPWORD,BOUNAM,COLNAM(IHELP(I)),UPBND
709   FORMAT(2A4,6X,A4,6X,F5.1)
      WRITE(6,609) UPWORD,BOUNAM,COLNAM(IHELP(I)),LPBND
609   FCRMAT(1H ,A4,A4,6X,A4,6X,F5.1)
900   CONTINUE
      WRITE(10,702) ENDAT
      WRITE(6 ,610) ENDAT
      END FILE 10
      STOP                                                              PRE02250
      END                                                               PREC2260
//GO.FTC3F001 DD UNIT=3330,DISP=SHR,VCL=SER=DISK03,CSN=S1948.KRIS.DATA1
//GC.FTC2F001 DD *
    1          1         5      0.99993718
    2          1         3      0.89108044
    3          1         5      0.45629483
    4          1         5      0.45483220
    5          1         5      0.73440230
.......................................
//GO.SYSIN DD *
  CL2AAT        8.         8.         9.         9.        10.
  CL2ARW       10.5       12.        12.        12.        12.
  CL2ASA       25.        25.        25.        25.        25.
```

```
 CL2ASY           0.          0.          0.          0.          C.
 CL2ATP           9.          9.         10.         10.         10.
.....................................................
//GC.FT10F001  DD UNIT=3330,VOL=SER=DISKC4,
//    DISP=(NEW,KEEP),DSN=S1948.DATACB,
//    SPACE=(TRK,200,RLSE),
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
```

```
***************************************************************************
*                                                                         *
*                           PROGRAM PREP-2                                *
*                                                                         *
*          PURPOSE : TO PREPARE THE INPUT DATA FOR MODEL-2                *
*                                                                         *
*       PROGRAMMER : CHRISTOS E. MAVRIKAS                                 *
*                                                                         *
*             DATE : DECEMBER 1978                                        *
*                                                                         *
***************************************************************************
//PREP$$2  JOB (1948,0552,RJ74,,11),'C.MAVRIKAS',TIME=4
//RDDATA EXEC  FORTCLG
//FORT.SYSIN  DD *
      REAL*4 CIV(8,20),MIL(8,20),CON(8,20),COST4(8,8),HOURS3(8,4),
     *COST5(8,4),MMY(36,5),FLHSUM(36,5)
      INTEGER    VTYP1(2), VTYP2(4), VTYP3(7), VTYP4(7), VTYP5(7),
     *VTYP6(2), VTYP7(5), VTYP8,     VTYP9(2), VTYP10(2),VTYP11(4),
     *VTYP12(3),VTYP13(2),VTYP14(7),VTYP15(3), VTYP16,    VTYP17(4),
     *VTYP18,    VTYP19(3),VTYP20,    VTYP21,    VTYP22(5),VTYP23(9),
     *VTYP24(2),VTYP25(3),VTYP26,    VTYP27,    VTYP28,    VTYP29(2),
     *VTYP30(2),VTYP31,    VTYP32(2),VTYP33,    VTYP34(4),VTYP35(2),
     *VTYP36(2),IMPNAM(61),IMP(61,4),IMPTOP(4),ICOUNT(61),EXTRA(11),
     *YEAR(5),ROWIMP,IMPVN
      INTEGER ID,RELIMP(4),JOBN(2),COLMNS(2),MARK(2),BOUND(2),ENDAT(2)
     *,ACTYPE(8,4),OBFNAM(2),               SDTYPE(36),BLANK
      INTEGER*2 CC(20),CCNAME(36),DIGIT(6),ROWGN1(2),FACC(35)
      DIMENSION COLUMN(416),IHELP(865),MAXFLH(36),RMMY(36),
     *COLNAM(950),TEMP(5),RHSN(415),COLN1(150),COLN2(150),COLN3(150),
     *COLN4(150),COLN5(150),COLN6(150),COLN7(50)
      DATA JOBN/'NAVA','IR  '/,COLMNS/'COLU','MNS '/,
     *MARK/'''MAR','KER'''/
     *,BOUND/'BOUN','DS  '/,ENDAT/'ENDA','TA  '/
      DATA DIGIT(1),DIGIT(2),DIGIT(3),DIGIT(4),DIGIT(5),DIGIT(6)/
     *'  ','AT','RW','SA','SY','TP'/
      DATA RCARD,TYPE1,TYPE2,NAM,RHSCAR,RHSNAM,UPWORD,BOUNAM/
     *'ROWS',' N  ',' L  ','NAME','RHS ','BRHS',' UP ','PROJ'/
      DATA BLANK/'    '/
C
C         PART 1
C
      DATA VTYP1/'KA3B','RA3B'/
      DATA VTYP2/'A4  ','A4E ','A4F ','A4M '/
      DATA VTYP3/'A6  ','A6A ','A6E ','EA6A','EA6B','NA6A','NEA6'/
      DATA VTYP4/'A7  ','A7A ','A7B ','A7C ','A7E ','A7EC','A7C/'/
      DATA VTYP5/'AV8 ','AV8A','AV8B','AV8C','A8  ','TAV8','AL8A'/
      DATA VTYP6/'A18 ','A18A'/
      DATA VTYP7/'C1A ','YC14','YC15','KCX ','VCX '/
```

```
      DATA VTYP8/'C2A '/
      DATA VTYP9/'EC13','KC13'/
      DATA VTYP10/'E2C ','E2CO'/
      DATA VTYP11/'F4  ','F4J ','F4S ','RF4B'/
      DATA VTYP12/'F14 ','F14A','F14B'/
      DATA VTYP13/'F18 ','F18A'/
      DATA VTYP14/'H1  ','HX  ','AH1 ','AH1G','AH1J','AH1T','EH1H'/
      DATA VTYP15/'H2  ','SH2 ','SH2F'/
      DATA VTYP16/'H3  '/
      DATA VTYP17/'H46 ','H46A','CH46','HH46'/
      DATA VTYP18/'CH47'/
      DATA VTYP19/'H53 ','CH53','RH53'/
      DATA VTYP20/'H58A'/
      DATA VTYP21/'H60 '/
      DATA VTYP22/'P3  ','P3A ','P3B ','P3C ','EP3E'/
      DATA VTYP23/'S3  ','S3A ','S3A0','S3B ','S3()','SH3G','SH3H',
     *'SH3K','S76 '/
      DATA VTYP24/'T2  ','T2C '/
      DATA VTYP25/'TA4 ','TA4J','TA4K'/
      DATA VTYP26/'TA7 '/
      DATA VTYP27/'NT33'/
      DATA VTYP28/'T34C'/
      DATA VTYP29/'T38 ','T38A'/
      DATA VTYP30/'T39 ','T39D'/
      DATA VTYP31/'T44A'/
      DATA VTYP32/'OV1 ','OV1B'/
      DATA VTYP33/'OV10'/
      DATA VTYP34/'UH1 ','UH1N','NU1B','UNK '/
      DATA VTYP35/'U6  ','U6A '/
      DATA VTYP36/'X26A','XR1D'/
C
C        PART 2
C
      DATA OBFNAM/'BENE','FITS'/,ROWGN1/'RC','RM'/,RCWIMP/'RIMP'/,IMPVN/
     *'IMPV'/,FACC/'01','02','03',
     *'04','05','06','07','08','09','10','11','12','13','14'
     *  ,'15','16','17','18','19','20','21','22','23','24','25','26','27
     *','28','29','30','31','32','33','34','35'/
      DATA EXTRA/'A1  ','C4  ','E1  ','F1  ','3 F ',' F-1','G2  ','J1  '
     *,' H-2','I-3 ','I-6 '/
C
C        PART 3
C
      DATA COLN1
     *       /'X001','X002','X003','X004','X005','X006','X007','X008',
     *'X009','X010','X011','X012','X013','X014','X015','X016','X017',
     *'X018','X019','X020','X021','X022','X023','X024','X025','X026',
     *'X027','X028','X029','X030','X031','X032','X033','X034','X035',
```

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*'X036','X037','X038','X039','X040','X041','X042','X043','X044',
*'X045','X046','X047','X048','X049','X050','X051','X052','X053',
*'X054','X055','X056','X057','X058','X059','X060','X061','X062',
*'X063','X064','X065','X066','X067','X068','X069','X070','X071',
*'X072','X073','X074','X075','X076','X077','X078','X079','X080',
*'X081','X082','X083','X084','X085','X086','X087','X088','X089',
*'X090','X091','X092','X093','X094','X095','X096','X097','X098',
*'X099','X100','X101','X102','X103','X104','X105','X106','X107',
*'X108','X109','X110','X111','X112','X113','X114','X115','X116',
*'X117','X118','X119','X120','X121','X122','X123','X124','X125',
*'X126','X127','X128','X129','X130','X131','X132','X133','X134',
*'X135','X136','X137','X138','X139','X140','X141','X142','X143',
*'X144','X145','X146','X147','X148','X149','X150'/
 DATA COLN2/'X151','X152',
*'X153','X154','X155','X156','X157','X158','X159','X160','X161',
*'X162','X163','X164','X165','X166','X167','X168','X169','X170',
*'X171','X172','X173','X174','X175','X176','X177','X178','X179',
*'X180','X181','X182','X183','X184','X185','X186','X187','X188',
*'X189','X190','X191','X192','X193','X194','X195','X196','X197',
*'X198','X199','X200','X201','X202','X203','X204','X205','X206',
*'X207','X208','X209','X210','X211','X212','X213','X214','X215',
*'X216','X217','X218','X219','X220','X221','X222','X223','X224',
*'X225','X226','X227','X228','X229','X230','X231','X232','X233',
*'X234','X235','X236','X237','X238','X239','X240','X241','X242',
*'X243','X244','X245','X246','X247','X248','X249','X250','X251',
*'X252','X253','X254','X255','X256','X257','X258','X259','X260',
*'X261','X262','X263','X264','X265','X266','X267','X268','X269',
*'X270','X271','X272','X273','X274','X275','X276','X277','X278',
*'X279','X280','X281','X282','X283','X284','X285','X286','X287',
*'X288','X289','X290','X291','X292','X293','X294','X295','X296',
*'X297','X298','X299','X300'/
 DATA COLN3/'X301','X302','X303','X304','X305',
*'X306','X307','X308','X309','X310','X311','X312','X313','X314',
*'X315','X316','X317','X318','X319','X320','X321','X322','X323',
*'X324','X325','X326','X327','X328','X329','X330','X331','X332',
*'X333','X334','X335','X336','X337','X338','X339','X340','X341',
*'X342','X343','X344','X345','X346','X347','X348','X349','X350',
*'X351','X352','X353','X354','X355','X356','X357','X358','X359',
*'X360','X361','X362','X363','X364','X365','X366','X367','X368',
*'X369','X370','X371','X372','X373','X374','X375','X376','X377',
*'X378','X379','X380','X381','X382','X383','X384','X385','X386',
*'X387','X388','X389','X390','X391','X392','X393','X394','X395',
*'X396','X397','X398','X399','X400','X401','X402','X403','X404',
*'X405','X406','X407','X408','X409','X410','X411','X412','X413',
*'X414','X415','X416','X417','X418','X419','X420','X421','X422',
*'X423','X424','X425','X426','X427','X428','X429','X430','X431',
*'X432','X433','X434','X435','X436','X437','X438','X439','X440',
*'X441','X442','X443','X444','X445','X446','X447','X448','X449',
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*'X450'/
 DATA COLN4/'X451','X452','X453','X454','X455','X456','X457','X458'
*,'X459','X460','X461','X462','X463','X464','X465','X466','X467',
*'X468','X469','X470','X471','X472','X473','X474','X475','X476',
*'X477','X478','X479','X480','X481','X482','X483','X484','X485',
*'X486','X487','X488','X489','X490','X491','X492','X493','X494',
*'X495','X496','X497','X498','X499','X500','X501','X502','X503',
*'X504','X505','X506','X507','X508','X509','X510','X511','X512',
*'X513','X514','X515','X516','X517','X518','X519','X520','X521',
*'X522','X523','X524','X525','X526','X527','X528','X529','X530',
*'X531','X532','X533','X534','X535','X536','X537','X538','X539',
*'X540','X541','X542','X543','X544','X545','X546','X547','X548',
*'X549','X550','X551','X552','X553','X554','X555','X556','X557',
*'X558','X559','X560','X561','X562','X563','X564','X565','X566',
*'X567','X568','X569','X570','X571','X572','X573','X574','X575',
*'X576','X577','X578','X579','X580','X581','X582','X583','X584',
*'X585','X586','X587','X588','X589','X590','X591','X592','X593',
*'X594','X595','X596','X597','X598','X599','X600'/
 DATA COLN5/'X601','X602',
*'X603','X604','X605','X606','X607','X608','X609','X610','X611',
*'X612','X613','X614','X615','X616','X617','X618','X619','X620',
*'X621','X622','X623','X624','X625','X626','X627','X628','X629',
*'X630','X631','X632','X633','X634','X635','X636','X637','X638',
*'X639','X640','X641','X642','X643','X644','X645','X646','X647',
*'X648','X649','X650','X651','X652','X653','X654','X655','X656',
*'X657','X658','X659','X660','X661','X662','X663','X664','X665',
*'X666','X667','X668','X669','X670','X671','X672','X673','X674',
*'X675','X676','X677','X678','X679','X680','X681','X682','X683',
*'X684','X685','X686','X687','X688','X689','X690','X691','X692',
*'X693','X694','X695','X696','X697','X698','X699','X700','X701',
*'X702','X703','X704','X705','X706','X707','X708','X709','X710',
*'X711','X712','X713','X714','X715','X716','X717','X718','X719',
$'X720','X721','X722','X723','X724','X725','X726','X727','X728',
*'X729','X730','X731','X732','X733','X734','X735','X736','X737',
*'X738','X739','X740','X741','X742','X743','X744','X745','X746',
*'X747','X748','X749','X750'/
 DATA COLN6/'X751','X752','X753','X754','X755',
*'X756','X757','X758','X759','X760','X761','X762','X763','X764',
*'X765','X766','X767','X768','X769','X770','X771','X772','X773',
*'X774','X775','X776','X777','X778','X779','X780','X781','X782',
*'X783','X784','X785','X786','X787','X788','X789','X790','X791',
*'X792','X793','X794','X795','X796','X797','X798','X799','X800',
*'X801','X802','X803','X804','X805','X806','X807','X808','X809',
*'X810','X811','X812','X813','X814','X815','X816','X817','X818',
*'X819','X820','X821','X822','X823','X824','X825','X826','X827',
*'X828','X829','X830','X831','X832','X833','X834','X835','X836',
*'X837','X838','X839','X840','X841','X842','X843','X844','X845',
*'X846','X847','X848','X849','X850','X851','X852','X853','X854',
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     *'X855','X856','X857','X858','X859','X860','X861','X862','X863',
     *'X864','X865','X866','X867','X868','X869','X870','X871','X872',
     *'X873','X874','X875','X876','X877','X878','X879','X880','X881',
     *'X882','X883','X884','X885','X886','X887','X888','X889','X890',
     *'X891','X892','X893','X894','X895','X896','X897','X898','X899',
     *'X900'/
      DATA COLN7/'X901','X902','X903','X904','X905','X906','X907','X908'
     *,'X909','X910','X911','X912','X913','X914','X915','X916','X917',
     *'X918','X919','X920','X921','X922','X923','X924','X925','X926',
     *'X927','X928','X929','X930','X931','X932','X933','X934','X935',
     *'X936','X937','X938','X939','X940','X941','X942','X943','X944',
     *'X945','X946','X947','X948','X949','X950'/
      EQUIVALENCE (COLNAM(1),COLN1(1)),(COLNAM(151),COLN2(1)),
     *(COLNAM(301),COLN3(1)),(COLNAM(451),COLN4(1)),(COLNAM(601),COLN5(1
     *)),(COLNAM(751),COLN6(1)),(COLNAM(901),COLN7(1))
C
C        PART 4
C
      DO 5 I=1,5
      YEAR(I)=I
5     CONTINUE
      DO 9 J=1,865
      IHELP(J)=0
9     CONTINUE
      DO 2 I=1,36
      READ(5,136) SDTYPE(I),MAXFLH(I),CCNAME(I),RMMY(I)
136   FORMAT(A4,6X,I3,7X,A2,8X,F4.2)
2     CONTINUE
      DO 22 I=1,61
      READ(5,137) IMPNAM(I),(IMP(I,K),K=1,4)
137   FORMAT(A4,6X,4(I4,6X))
22    CONTINUE
      READ(5,138) (IMPTOP(I),I=1,4)
138   FORMAT(4(I5,5X))
      GARB=0
      DO 23 J=1,61
      ICOUNT(J)=0
23    CONTINUE
      N=0
C
C        PART 5
C
1     READ(5,END=500) ID,RELIMP,CC,CIV,MIL,CON,ACTYPE,HOURS3,COST4,COST5
      N=N+1
11    READ(2,200,END=500) JOB,KSTART,KEND,BENEF
200   FORMAT(I6,2(5X,I5),5X,F10.8)
12    IF (ID.NE.JOB) GO TO 450
      IF(KSTART.EQ.0) GO TO 1
```

```
      IHELP(N)=ID
      COLUMN(1)=BENEF
      DO 50 I=2,416
      COLUMN(I)=0.0
50    CONTINUE
C
C        PART 6
C
      DO 300 L=1,19
      IF(CC(L).EQ.DIGIT(1)) GO TO 300
      IF(L.LE.4) GO TO 150
      DO 140 K=KSTART,KEND
      INDEX1=17+L+35*(K-1)
      INDEM1=192+L+35*(K-1)
      INDEX2=1+K
      COLUMN(INDEX1)=CIV(INDEX2,L)
      COLUMN(INDEM1)=MIL(INDEX2,L)
140   CONTINUE
      GO TO 300
150   DO 270 K=KSTART,KEND
      IF(CC(L).EQ.DIGIT(6)) GO TO 240
      IF(CC(L).EQ.DIGIT(5)) GO TO 230
      IF(CC(L).EQ.DIGIT(4)) GO TO 220
      IF(CC(L).EQ.DIGIT(3)) GO TO 210
      IF(CC(L).NE.DIGIT(2)) GO TO 260
      INDEX1=2+5*(L-1)+35*(K-1)
      INDEM1=177+5*(L-1)+35*(K-1)
      GO TO 250
210   INDEX1=3+5*(L-1)+35*(K-1)
      INDEM1=178+5*(L-1)+35*(K-1)
      GO TO 250
220   INDEX1=4+5*(L-1)+35*(K-1)
      INDEM1=179+5*(L-1)+35*(K-1)
      GO TO 250
230   INDEX1=5+5*(L-1)+35*(K-1)
      INDEM1=180+5*(L-1)+35*(K-1)
      GO TO 250
240   INDEX1=6+5*(L-1)+35*(K-1)
      INDEM1=181+5*(L-1)+35*(K-1)
250   INDEX2=1+K
      COLUMN(INDEX1)=CIV(INDEX2,L)
      COLUMN(INDEM1)=MIL(INDEX2,L)
      GO TO 270
260   WRITE(6,265) ID,L,CC
265   FORMAT(10X,25HERRCR IN COST CENTER CODE 5X,5HID = ,I6,5X,4HL = ,
     *I2,5X,5HCC = ,A2)
270   CONTINUE
300   CONTINUE
```

```
C
C        PART 7
C
      DC 4 J=1,36
      DC 3 K=1,5
      FLHSUM(J,K)=0.
3     CCNTINUE
4     CONTINUE
C
C        PART 8
C
      CC 14 L=1,4
      DO 10 K=KSTART,KEND
      K1=K+1
      IF(ACTYPE(K1,L).EC.BLANK) GO TO 1C
      DO 8 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP1(J)) GO TO 17
8     CCNTINUE
      GO TO 18
17    FLHSUM(1,K)=FLHSUM(1,K)+HOURS3(K1,L)
      GC TO 10
18    DO 19 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP2(J)) GO TO 21
19    CCNTINUE
      GO TO 28
21    FLHSUM(2,K)=FLHSUM(2,K)+HOURS3(K1,L)
      GO TO 10
28    DO 29 J=1,7
      IF(ACTYPE(K1,L).EC.VTYP3(J)) GO TO 31
29    CONTINUE
      GC TO 32
31    FLHSUM(3,K)=FLHSUM(3,K)+HOURS3(K1,L)
      GO TO 10
32    CC 33 J=1,7
      IF(ACTYPE(K1,L).EC.VTYP4(J)) GO TC 34
33    CONTINUE
      GC TO 35
34    FLHSUM(4,K)=FLHSUM(4,K)+HOURS3(K1,L)
      GC TO 10
35    DC 36 J=1,7
      IF(ACTYPE(K1,L).EC.VTYP5(J)) GO TO 37
36    CCNTINUE
      GC TO 38
37    FLHSUM(5,K)=FLHSUM(5,K)+HOURS3(K1,L)
      GC TO 10
38    DC 39 J=1,2
      IF(ACTYPE(K1,L).EC.VTYP6(J)) GO TC 40
39    CCNTINUE
```

```
      GO TO 41
40    FLHSUM(6,K)=FLHSUM(6,K)+HOURS3(K1,L)
      GO TO 10
41    DO 42 J=1,5
      IF(ACTYPE(K1,L).EQ.VTYP7(J)) GO TO 43
42    CONTINUE
      GO TO 44
43    FLHSUM(7,K)=FLHSUM(7,K)+HOURS3(K1,L)
      GO TO 10
44    IF(ACTYPE(K1,L).EQ.VTYP8) GO TO 46
      GO TO 47
46    FLHSUM(8,K)=FLHSUM(8,K)+HOURS3(K1,L)
      GO TO 10
47    DO 48 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP9(J)) GO TO 49
48    CONTINUE
      GO TO 51
49    FLHSUM(9,K)=FLHSUM(9,K)+HOURS3(K1,L)
      GO TO 10
51    DO 52 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP10(J)) GO TO 53
52    CONTINUE
      GO TO 54
53    FLHSUM(10,K)=FLHSUM(10,K)+HOURS3(K1,L)
      GO TO 10
54    DO 55 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP11(J)) GO TO 56
55    CONTINUE
      GO TO 57
56    FLHSUM(11,K)=FLHSUM(11,K)+HOURS3(K1,L)
      GO TO 10
57    DO 58 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP12(J)) GO TO 59
58    CONTINUE
      GO TO 60
59    FLHSUM(12,K)=FLHSUM(12,K)+HOURS3(K1,L)
      GO TO 10
60    DO 61 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP13(J)) GO TO 62
61    CONTINUE
      GO TO 63
62    FLHSUM(13,K)=FLHSUM(13,K)+HOURS3(K1,L)
      GO TO 10
63    DO 64 J=1,7
      IF(ACTYPE(K1,L).EQ.VTYP14(J)) GO TO 65
64    CONTINUE
      GO TO 66
65    FLHSUM(14,K)=FLHSUM(14,K)+HOURS3(K1,L)
```

```
      GO TO 10
66    DO 67 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP15(J)) GO TO 68
67    CONTINUE
      GO TO 69
68    FLHSUM(15,K)=FLHSUM(15,K)+HOURS3(K1,L)
      GO TO 10
69    IF(ACTYPE(K1,L).EQ.VTYP16)     GO TO 71
      GO TO 72
71    FLHSUM(16,K)=FLHSUM(16,K)+HOURS3(K1,L)
      GO TO 10
72    DO 73 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP17(J)) GO TO 74
73    CONTINUE
      GO TO 75
74    FLHSUM(17,K)=FLHSUM(17,K)+HOURS3(K1,L)
      GO TO 10
75    IF(ACTYPE(K1,L).EQ.VTYP18) GO TO 77
      GO TO 78
77    FLHSUM(18,K)=FLHSUM(18,K)+HOURS3(K1,L)
      GO TO 10
78    DO 79 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP19(J)) GO TO 80
79    CONTINUE
      GO TO 81
80    FLHSUM(19,K)=FLHSUM(19,K)+HOURS3(K1,L)
      GO TO 10
81    IF(ACTYPE(K1,L).EQ.VTYP20) GO TO 83
      GO TO 84
83    FLHSUM(20,K)=FLHSUM(20,K)+HOURS3(K1,L)
      GO TO 10
84    IF(ACTYPE(K1,L).EQ.VTYP21) GO TO 86
      GO TO 87
86    FLHSUM(21,K)=FLHSUM(21,K)+HOURS3(K1,L)
      GO TO 10
87    DO 88 J=1,5
      IF(ACTYPE(K1,L).EQ.VTYP22(J)) GO TO 89
88    CONTINUE
      GO TO 90
89    FLHSUM(22,K)=FLHSUM(22,K)+HOURS3(K1,L)
      GO TO 10
90    DO 91 J=1,9
      IF(ACTYPE(K1,L).EQ.VTYP23(J)) GO TO 92
91    CONTINUE
      GO TO 93
92    FLHSUM(23,K)=FLHSUM(23,K)+HOURS3(K1,L)
      GO TO 10
93    DO 94 J=1,2
```

```
      IF(ACTYPE(K1,L).EC.VTYP24(J)) GO TO 95
94    CONTINUE
      GC TO 96
95    FLHSUM(24,K)=FLHSUM(24,K)+HOURS3(K1,L)
      GO TO 10
96    CC 97 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP25(J)) GC TC 98
97    CONTINUE
      GO TO 99
98    FLHSUM(25,K)=FLHSLM(25,K)+HOURS3(K1,L)
      GC TO 10
99    IF(ACTYPE(K1,L).EC.VTYP26) GO TC 101
      GO TO 102
101   FLHSUM(26,K)=FLHSUM(26,K)+HOURS3(K1,L)
      GO TO 10
102   IF(ACTYPE(K1,L).EC.VTYP27) GO TO 1C4
      GC TC 105
104   FLHSUM(27,K)=FLHSUM(27,K)+HOURS3(K1,L)
      GC TO 10
105   IF(ACTYPE(K1,L).EC.VTYP28)     GO TO 107
      GO TO 108
107   FLHSUM(28,K)=FLHSUM(28,K)+HOURS3(K1,L)
      GO TO 10
108   DJ 109 J=1,2
      IF(ACTYPE(K1,L).EC.VTYP29(J)) GO TO 111
109   CONTINUE
      GC TO 112
111   FLHSUM(29,K)=FLHSUM(29,K)+HOURS3(K1,L)
      GO TO 10
112   DC 113 J=1,2
      IF(ACTYPE(K1,L).EC.VTYP30(J)) GO TO 114
113   CONTINUE
      GC TC 115
114   FLHSUM(30,K)=FLHSUM(30,K)+HCURS3(K1,L)
      GC TO 10
115   IF(ACTYPE(K1,L).EC.VTYP31)     GO TO 117
      GO TO 118
117   FLHSUM(31,K)=FLHSUM(31,K)+HOURS3(K1,L)
      GO TO 10
118   DO 119 J=1,2
      IF(ACTYPE(K1,L).EC.VTYP32(J)) GO TO 121
119   CONTINUE
      GC TO 122
121   FLHSUM(32,K)=FLHSUM(32,K)+HOURS3(K1,L)
      GO TO 10
122   IF(ACTYPE(K1,L).EQ.VTYP33)     GC TC 124
      GO TO 125
124   FLHSUM(33,K)=FLHSUM(33,K)+HOURS3(K1,L)
```

```
      GO TO 10
125   DO 126 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP34(J)) GO TO 127
126   CONTINUE
      GO TO 128
127   FLHSUM(34,K)=FLHSUM(34,K)+HOURS3(K1,L)
      GO TO 10
128   DO 129 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP35(J)) GO TO 130
129   CONTINUE
      GO TO 131
130   FLHSUM(35,K)=FLHSUM(35,K)+HOURS3(K1,L)
      GO TO 10
131   DO 132 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP36(J)) GO TO 133
132   CONTINUE
      GO TO 134
133   FLHSUM(36,K)=FLHSUM(36,K)+HOURS3(K1,L)
      GO TO 10
134   WRITE(6,135) ACTYPE(K1,L),HOURS3(K1,L),ID,K
135   FORMAT(1H ,24HUNKNOWN AIRCRAFT TYPE : ,A4,5X,14HFLIGT HOURS : ,F5.
     *0,5X,5HID = ,I6,5X,12HPLAN.YEAR = ,I1)
      GARB=GARB+HOURS3(K1,L)
10    CONTINUE
C
C        PART 9
C
      IF(RELIMP(L).EQ.BLANK) GO TO 14
      DO 139 J=1,61
      IF(RELIMP(L).EQ.IMPNAM(J)) GO TO 161
139   CONTINUE
      IF(RELIMP(L).EQ.EXTRA(1)) GO TO 142
      IF(RELIMP(L).EQ.EXTRA(2)) GO TO 143
      IF(RELIMP(L).EQ.EXTRA(3)) GO TO 144
      IF(RELIMP(L).EQ.EXTRA(4)) GO TO 145
      IF(RELIMP(L).EQ.EXTRA(5)) GO TO 146
      IF(RELIMP(L).EQ.EXTRA(6)) GO TO 147
      IF(RELIMP(L).EQ.EXTRA(7)) GO TO 148
      IF(RELIMP(L).EQ.EXTRA(8)) GO TO 149
      IF(RELIMP(L).EQ.EXTRA(9)) GO TO 151
      IF(RELIMP(L).EQ.EXTRA(10)) GO TO 152
      IF(RELIMP(L).EQ.EXTRA(11)) GO TO 153
      WRITE(6,154) ID,RELIMP(L)
154   FORMAT(1H ,10X,5HID = ,I6,5X,14HUNKNOWN IMP : ,A4)
      GO TO 14
142   J=1
      GO TO 161
143   J=17
```

```
      GC TC 161
144   J=22
      GC TO 161
145   J=27
      GO TO 161
146   J=30
      GO TO 161
147   J=27
      GC TO 161
148   J=38
      GC TO 161
149   J=46
      GO TO 161
151   J=48
      GC TO 161
152   J=51
      GC TO 161
153   J=54
161   INDEX3=351+J
      CCLUMN(INDEX3)=1.0
      ICOUNT(J)=ICCUNT(J)+1
14    CONTINUE
C
C        PART 10
C
      DC 360 K=KSTART,KEND
      TOTAL1=0.
      TCTAL2=0.
      TCTAL3=0.
      TOTAL4=0.
      DC 350 J=1,36
      IF(FLHSUM(J,K).EQ.0.) GO TO 350
      MMY(J,K)=FLHSUM(J,K)*RMMY(J)/100.
      IF(CCNAME(J).EQ.DIGIT(4)) GO TO 341
      IF(CCNAME(J).EQ.DIGIT(2)) GO TO 342
      IF(CCNAME(J).EQ.DIGIT(3)) GO TO 343
      IF(CCNAME(J).NE.DIGIT(6)) GO TO 344
      TOTAL4=TOTAL4+MMY(J,K)
      GO TO 350
341   TCTAL3=TCTAL3+MMY(J,K)
      GO TO 350
342   TCTAL1=TOTAL1+MMY(J,K)
      GC TO 350
343   TCTAL2=TOTAL2+MMY(J,K)
      GC TO 350
344   WRITE(6,345) ID,J,SDTYPE(J),CCNAME(J)
345   FORMAT(1H ,23HERROR IN CCNAME : IC = ,I6,5X,4HJ = ,I2,9HSDTYPE = ,
     *A4,5X,9HCCNAME = ,A2)
```

```
350   CONTINUE
      INDEX4=192+35*(K-1)
      INDEX5=193+35*(K-1)
      INDEX6=194+35*(K-1)
      INDEX7=196+35*(K-1)
      IF(TOTAL1.GT.COLUMN(INDEX4)) COLUMN(INDEX4)=TOTAL1
      IF(TOTAL2.GT.COLUMN(INDEX5)) COLUMN(INDEX5)=TOTAL2
      IF(TOTAL3.GT.COLUMN(INDEX6)) COLUMN(INDEX6)=TOTAL3
      IF(TOTAL4.GT.COLUMN(INDEX7)) COLUMN(INDEX7)=TOTAL4
360   CONTINUE
C
C        PART 11
C
      IF(N.GT.1) GO TO 415
      WRITE(10,400) NAM,JOBN
400   FORMAT(A4,10X,2A4)
      WRITE(6,600)  NAM,JOBN
600   FORMAT(1H ,A4,10X,2A4)
      WRITE(10,701) RCARD
701   FORMAT(A4)
      WRITE(6,601) RCARD
601   FORMAT(1H ,A4)
      WRITE(10,702)   TYPE1,OBFNAM
      WRITE(6,602)    TYPE1,OBFNAM
702   FORMAT(3A4)
602   FORMAT(1H ,A4,2A4)
C
C        PART 12
C
      DO 412 L=1,2
      DO 410 K=1,5
      DO 405 I=1,35
      WRITE(10,712) TYPE2,ROWGN1(L),FACC(I),YEAR(K)
      WRITE(6,612) TYPE2,ROWGN1(L),FACC(I),YEAR(K)
712   FORMAT(A4,2A2,I1)
612   FORMAT(1H ,A4,2A2,I1 )
405   CONTINUE
410   CONTINUE
412   CONTINUE
C
C        PART 13
C
      DO 515 L=1,65
      IF(L.GT.9) GO TO 413
      WRITE(10,714) TYPE2,ROWIMP,FACC(L)
      WRITE(6,614) TYPE2,ROWIMP,FACC(L)
714   FORMAT(2A4,A2)
614   FORMAT(1H ,2A4,A2)
```

```
      GO TO 515
413   WRITE(10,715) TYPE2,ROWIMP,L
      WRITE(6,615) TYPE2,ROWIMP,L
715   FORMAT(2A4,I2)
615   FORMAT(1H ,2A4,I2)
515   CONTINUE
C
C        PART 14
C
      WRITE(10,702) COLMNS
      WRITE(6,610) COLMNS
610   FORMAT(1H ,2A4)
415   WRITE(10,703) COLNAM(ID),OBFNAM,COLUMN(1)
703   FORMAT(4X,A4,6X,2A4,2X,F12.8)
      WRITE(6,603) COLNAM(ID),OBFNAM,COLUMN(1)
603   FORMAT(1H ,4X,A4,6X,2A4,2X,F12.8)
C
C        PART 15
C
      DO 420 L=1,2
      DO 418 K=1,5
      DO 416 I=1,35
      INDEX=175*(L-1)+35*(K-1)+I+1
      IF(COLUMN(INDEX).EQ.0.) GO TO 416
      WRITE(10,704) COLNAM(ID),ROWGN1(L),FACC(I),YEAR(K),COLUMN(INDEX)
      WRITE( 6,604) COLNAM(ID),ROWGN1(L),FACC(I),YEAR(K),COLUMN(INDEX)
704   FORMAT(4X,A4,6X,2A2,I1,5X,F5.1)
604   FORMAT(1H ,4X,A4,6X,2A2,I1,5X,F5.1)
416   CONTINUE
418   CONTINUE
420   CONTINUE
C
C        PART 16
C
      DO 425 L=1,61
      INDEX=351+L
      IF(COLUMN(INDEX).EQ.0.) GO TO 425
      IF(L.GT.9) GO TO 421
      WRITE(10,724) COLNAM(ID),ROWIMP,FACC(L),COLUMN(INDEX)
      WRITE(6,624) COLNAM(ID),ROWIMP,FACC(L),COLUMN(INDEX)
724   FORMAT(4X,A4,6X,A4,A2,4X,F5.1)
624   FORMAT(1H ,4X,A4,6X,A4,A2,4X,F5.1)
      GO TO 425
421   WRITE(10,726) COLNAM(ID),ROWIMP,L,COLUMN(INDEX)
      WRITE(6,626) COLNAM(ID),ROWIMP,L,COLUMN(INDEX)
726   FORMAT(4X,A4,6X,A4,I2,4X,F5.1)
626   FORMAT(1H ,4X,A4,6X,A4,I2,4X,F5.1)
425   CONTINUE
```

```
      GO TO 1
C
C        PART 17
C
450   WRITE(6,606) ID,JOB
606   FORMAT(10X,46HID OF PRIO AND MASTER DO NOT MATCH : MASTER = ,I6,5X
     *,7HPRIO = ,I6)
      IF(ID.GT.JOB) GO TO 11
      DO 15 I=1,20
      IF(I.GT.1) GO TO 25
      WRITE(6,110) ID
110   FORMAT(10X,I6//)
25    WRITE(6,120) CC(I),(CIV(M,I),M=2,6)
120   FORMAT(10X,A2,5(F5.1,5X))
15    CONTINUE
      READ(3,END=500) ID,RELIMP,CC,CIV,MIL,CON,ACTYPE,HOURS3,COST4,COST5
      GO TO 12
500   CONTINUE
C
C        PART 18
C
      DO 770 J=1,61
      IF(ICOUNT(J).EQ.0) GO TO 770
      DO 735 I=352,416
      COLUMN(I)=0.0
735   CONTINUE
      INDEX=351+J
      COLUMN(INDEX)=-ICOUNT(J)
      DO 740 I=1,4
      INDEX=412+I
      COLUMN(INDEX)=IMP(J,I)
740   CONTINUE
      DO 765 I=352,416
      IF(COLUMN(I).EQ.0.) GO TO 765
      L=I-351
      IF(J.GT.9) GO TO 744
      IF(L.GT.9) GO TO 742
      WRITE(10,741) IMPVN,FACC(J),ROWIMP,FACC(L),COLUMN(I)
      WRITE( 6,641) IMPVN,FACC(J),ROWIMP,FACC(L),COLUMN(I)
741   FORMAT(     4X,A4,A2,4X,A4,A2,4X,F7.1)
641   FORMAT(1H ,4X,A4,A2,4X,A4,A2,4X,F7.1)
      GO TO 765
742   WRITE(10,743) IMPVN,FACC(J),ROWIMP,L,COLUMN(I)
      WRITE( 6,643) IMPVN,FACC(J),ROWIMP,L,COLUMN(I)
743   FORMAT(     4X,A4,A2,4X,A4,I2,4X,F7.1)
643   FORMAT(1H ,4X,A4,A2,4X,A4,I2,4X,F7.1)
      GO TO 765
744   IF(L.GT.9) GO TO 746
```

```
      WRITE(10,745) IMPVN,J,ROWIMP,FACC(L),COLUMN(I)
      WRITE(6,645) IMPVN,J,ROWIMP,FACC(L),COLUMN(I)
745   FORMAT(4X,A4,I2,4X,A4,A2,4X,F7.1)
645   FORMAT(1H ,4X,A4,I2,4X,A4,A2,4X,F7.1)
      GO TO 765
746   WRITE(10,747) IMPVN,J,ROWIMP,L,COLUMN(I)
747   FORMAT(4X,A4,I2,4X,A4,I2,4X,F7.1)
      WRITE(6,647) IMPVN,J,ROWIMP,L,COLUMN(I)
647   FORMAT(1H ,4X,A4,I2,4X,A4,I2,4X,F7.1)
765   CONTINUE
770   CONTINUE
C
C        PART 19
C
      WRITE(10,701) RHSCAR
      WRITE(6,605)  RHSCAR
605   FORMAT(1H ,A4)
      DO 700 L=1,35
      READ(5,607)  (TEMP(I),I=1,5)
607   FORMAT(10X,5F10.1)
      DO 650 K=1,5
      INDEX= L+35*(K-1)
      RHSN(INDEX)=TEMP(K)
650   CONTINUE
700   CONTINUE
C
C        PART 20
C
      DO 750 L=1,35
      READ(5,607) (TEMP(I),I=1,5)
      DO 720 K=1,5
      INDEX8=175+L+35*(K-1)
      RHSN(INDEX8)=TEMP(K)
720   CONTINUE
750   CONTINUE
      DO 760 J=351,411
      RHSN(J)=0.
760   CONTINUE
      DO 775 J=1,4
      RHSN(411+J)=IMPTOP(J)
775   CONTINUE
      INDEX=0
C
C        PART 21
C
      DO 800 L=1,2
      DO 790 K=1,5
      DO 780 I=1,35
```

```
      INDEX=INDEX+1
      WRITE(10,704) RHSNAM,ROWGN1(L),FACC(I),YEAR(K),RHSN(INDEX)
      WRITE( 6,604) RHSNAM,ROWGN1(L),FACC(I),YEAR(K),RHSN(INDEX)
780   CONTINUE
790   CONTINUE
800   CONTINUE
C
C         PART 22
C
      DO 850  L=1,65
      INDEX=INDEX+1
      IF(L.GT.9) GO TO 840
      WRITE(10,724) RHSNAM,ROWIMP,FACC(L),RHSN(INDEX)
      WRITE( 6,624) RHSNAM,ROWIMP,FACC(L),RHSN(INDEX)
      GO TO 850
840   WRITE(10,791) RHSNAM,ROWIMP,L,RHSN(INDEX)
      WRITE( 6,691) RHSNAM,ROWIMP,L,RHSN(INDEX)
691   FORMAT(1H ,4X,A4,6X,A4,I2,4X,F7.1)
791   FORMAT(4X,A4,6X,A4,I2,4X,F7.1)
850   CONTINUE
C
C         PART 23
C
      WRITE(10,702) BOUND
      WRITE(6,610) BOUND
      UPBND=1.0
      DO 900  I=1,N
      IF(IHELP(I).EQ.0) GO TO 900
      WRITE(10,709) UPWORD,BOUNAM,COLNAM(IHELP(I)),UPBND
709   FORMAT(2A4,6X,A4,6X,F5.1)
      WRITE(6,609) UPWORD,BOUNAM,COLNAM(IHELP(I)),UPBND
609   FORMAT(1H ,A4,A4,6X,A4,6X,F5.1)
900   CONTINUE
C
C         PART 24
C
      DO 950  J=1,61
      IF(ICOUNT(J).EQ.0) GO TO 950
      IF(J.GT.9) GO TO 930
      WRITE(10,911) UPWORD,BOUNAM,IMPVN,FACC(J),UPBND
      WRITE( 6,912) UPWORD,BOUNAM,IMPVN,FACC(J),UPBND
911   FORMAT(2A4,6X,A4,A2,4X,F5.1)
912   FORMAT(1H ,2A4,6X,A4,A2,4X,F5.1)
      GO TO 950
930   WRITE(10,913) UPWORD,BOUNAM,IMPVN,J,UPBND
      WRITE( 6,914) UPWORD,BOUNAM,IMPVN,J,UPBND
913   FORMAT(2A4,6X,A4,I2,4X,F5.1)
914   FORMAT(1H ,2A4,6X,A4,I2,4X,F5.1)
```

```
950    CONTINUE
       WRITE(10,702) ENDAT
       WRITE(6,610) ENDAT
       END FILE 10
       WRITE(6,960) GARB
960    FORMAT(1H ,10X,10HGARBAGE = ,F5.0,5X,12HFLIHGT HOURS)
       STOP
       END
//GO.FT03F001 DD UNIT=3330,DISP=SHR,VOL=SER=DISK03,DSN=S1948.KRIS.DATA2
//GO.SYSIN DD *
A3          250        SA         1.29
A4          500        SA          .76
A6          350        SA         2.21
A7          300        SA         1.36
AV8         250        SA         2.03
...................................................................
  A1         490        810        840        915
  A2        1076        500        500        500
  A3         265        600        490        600
  A4         500        550        150          0
  A5           0       1000        400       1800
...................................................................
  CL2AAT           8.          8.          9.          9.         10.
  CL2ARW          10.5        12.         12.         12.         12.
  CL2ASA          25.         25.         25.         25.         25.
  CL2ASY           0.          0.          0.          0.          0.
  CL2ATP           9.          9.         10.         10.         10.
...................................................................
                   7.          7.          7.          7.          7.
                   4.          4.          4.          4.          4.
                  10.         10.         10.         10.         10.
                   0.          0.          0.          0.          0.
                  14.         14.         14.         14.         14.
...................................................................
//GO.FT02F001 DD *
     1          1          5      0.99993718
     2          1          3      0.89108044
     3          1          5      0.45629483
     4          1          5      0.45483220
     5          1          5      0.73440230
...................................................................
//GO.FT10F001 DD UNIT=3330,VOL=SER=DISK03,
//   DISP=(NEW,KEEP),DSN=S1948.DATAGM,
//   SPACE=(TRK,200,RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
```

```
***************************************************************
*                                                             *
*                      PROGRAM PREP-3                         *
*                                                             *
*        PURPOSE : TO PREPARE THE INPUT DATA FOR MODEL-3      *
*                                                             *
*     PROGRAMMER : CHRISTOS E. MAVRIKAS                       *
*                                                             *
*           DATE : JANUARY 1979                               *
*                                                             *
***************************************************************
//PREP$$3  JOB (1948,0552,RJ74,,50),'C.MAVRIKAS',TIME=8
//RCDATA EXEC  FORTCLG
//FORT.SYSIN  DD *
      REAL*4 CIV(8,20),MIL(8,20),CON(8,20),COST4(8,8),HOURS3(8,4),
     *COST5(8,4),MMY(36,5),FLHSUM(36,5),RECOST(35,35),TREMA(19)
      INTEGER   VTYP1(2), VTYP2(4), VTYP3(7), VTYP4(7), VTYP5(7),
     *VTYP6(2), VTYP7(5), VTYP8,     VTYP9(2), VTYP10(2),VTYP11(4),
     *VTYP12(3),VTYP13(2),VTYP14(7),VTYP15(3),VTYP16,    VTYP17(4),
     *VTYP18,   VTYP19(3),VTYP20,    VTYP21,    VTYP22(5),VTYP23(9),
     *VTYP24(2),VTYP25(3),VTYP26,    VTYP27,    VTYP28,    VTYP29(2),
     *VTYP30(2),VTYP31,    VTYP32(2),VTYP33,    VTYP34(4),VTYP35(2),
     *VTYP36(2),IMPNAM(61),IMP(61,4),IMPTOP(4),ICOLNT(61),EXTRA(11),
     *YEAR(5),ROWIMP,IMPVN
      INTEGER ID,RELIMP(4),JOBN(2),COLMNS(2),MARK(2),BOUND(2),ENDAT(2)
     *,ACTYPE(8,4),OBFNAM(2),CONSTR(2),   SDTYPE(36),BLANK
      INTEGER*2 CC(20),CCNAME(36),DIGIT(6),ROWGN1(2),FACC(35),VYNAM(2)
      DIMENSION COLUMN(766),IHELP(865),MAXFLH(36),RMMY(36),
     *COLNAM(950),TEMP(5),RHSN(765),COLN1(150),COLN2(150),COLN3(150),
     *COLN4(150),COLN5(150),COLN6(150),COLN7(50)
      DATA JOBN/'NAVA','IR  '/,COLMNS/'COLU','MNS '/,
     *MARK/'''MAR','KER'''/
     *,BOUND/'BOUN','DS  '/,ENDAT/'ENDA','TA  '/
      DATA DIGIT(1),DIGIT(2),DIGIT(3),DIGIT(4),DIGIT(5),DIGIT(6)/
     *'  ','AT','RW','SA','SY','TP'/
      DATA RCARD,TYPE1,TYPE2,NAM,RHSCAR,RHSNAM,UPWORD,BCUNAM/
     *'ROWS',' N  ',' L  ','NAME','RHS ','BRHS',' UP ','PROJ'/
      DATA BLANK/'    '/
C
C        PART 1
C
      DATA VTYP1/'KA3B','RA3B'/
      DATA VTYP2/'A4  ','A4E ','A4F ','A4M '/
      DATA VTYP3/'A6  ','A6A ','A6E ','EA6A','EA6B','NA6A','NEA6'/
      DATA VTYP4/'A7  ','A7A ','A7B ','A7C ','A7E ','A7EC','A7C/'/
      DATA VTYP5/'AV8 ','AV8A','AV8B','AV8C','A8  ','TAV8','AU8A'/
      DATA VTYP6/'A18 ','A18A'/
      DATA VTYP7/'C1A ','YC14','YC15','KCX ','VCX '/
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      DATA VTYP8/'C2A  '/
      DATA VTYP9/'EC13','KC13'/
      DATA VTYP10/'E2C ','E2C0'/
      DATA VTYP11/'F4  ','F4J ','F4S ','RF4B'/
      DATA VTYP12/'F14 ','F14A','F14B'/
      DATA VTYP13/'F18 ','F18A'/
      DATA VTYP14/'H1  ','HX  ','AH1 ','AH1G','AH1J','AH1T','EH1H'/
      DATA VTYP15/'H2  ','SH2 ','SH2F'/
      DATA VTYP16/'H3  '/
      DATA VTYP17/'H46 ','H46A','CH46','HH46'/
      DATA VTYP18/'CH47'/
      DATA VTYP19/'H53 ','CH53','RH53'/
      DATA VTYP20/'H58A'/
      DATA VTYP21/'H60 '/
      DATA VTYP22/'P3  ','P3A ','P3B ','P3C ','EP3E'/
      DATA VTYP23/'S3  ','S3A ','S3A0','S3B ','S3()','SH3G','SH3H',
     *'SH3K','S76 '/
      DATA VTYP24/'T2  ','T2C '/
      DATA VTYP25/'TA4 ','TA4J','TA4K'/
      DATA VTYP26/'TA7 '/
      DATA VTYP27/'NT33'/
      DATA VTYP28/'T34C'/
      DATA VTYP29/'T38 ','T38A'/
      DATA VTYP30/'T39 ','T39D'/
      DATA VTYP31/'T44A'/
      DATA VTYP32/'OV1 ','OV1B'/
      DATA VTYP33/'OV10'/
      DATA VTYP34/'UH1 ','UH1N','NU1B','UNK '/
      DATA VTYP35/'U6  ','U6A '/
      DATA VTYP36/'X26A','XR1D'/
      DATA VYNAM/'YC','YM'/
C
C        PART 2
C
      DATA OBFNAM/'BENE','FITS'/,ROWGN1/'RC','RM'/,ROWIMP/'RIMP'/,IMPVN/
     *'IMPV'/,FACC/'01','02','03',
     *'04','05','06','07','08','09','10','11','12','13','14'
     * ,'15','16','17','18','19','20','21','22','23','24','25','26','27
     *','28','29','30','31','32','33','34','35'/
      DATA EXTRA/'A1  ','C4  ','E1  ','F1  ','3 F ',' F-1','G2  ','J1  '
     *,' H-2','I-3 ','I-6 '/
C
C        PART 3
C
      DATA COLN1
     *     /'X001','X002','X003','X004','X005','XCC6','XCC7','XC08',
     *'XCC9','X01C','X011','X012','X013','X014','X015','X016','X017',
     *'X018','X019','X020','X021','X022','X023','X024','X025','X026',
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*'X027','X028','X029','X030','X031','X032','X033','X034','X035',
*'X036','X037','X038','X039','X040','X041','X042','X043','X044',
*'X045','X046','X047','X048','X049','X050','X051','X052','X053',
*'X054','X055','X056','X057','X058','X059','X060','X061','X062',
*'X063','X064','X065','X066','X067','X068','X069','X070','X071',
*'X072','X073','X074','X075','X076','X077','X078','X079','X080',
*'X081','X082','X083','X084','X085','X086','X087','X088','X089',
*'X090','X091','X092','X093','X094','X095','X096','X097','X098',
*'X099','X100','X101','X102','X103','X104','X105','X106','X107',
*'X108','X109','X110','X111','X112','X113','X114','X115','X116',
*'X117','X118','X119','X120','X121','X122','X123','X124','X125',
*'X126','X127','X128','X129','X130','X131','X132','X133','X134',
*'X135','X136','X137','X138','X139','X140','X141','X142','X143',
*'X144','X145','X146','X147','X148','X149','X150'/
 DATA COLN2/'X151','X152',
*'X153','X154','X155','X156','X157','X158','X159','X160','X161',
*'X162','X163','X164','X165','X166','X167','X168','X169','X170',
*'X171','X172','X173','X174','X175','X176','X177','X178','X179',
*'X180','X181','X182','X183','X184','X185','X186','X187','X188',
*'X189','X190','X191','X192','X193','X194','X195','X196','X197',
*'X198','X199','X200','X201','X202','X203','X204','X205','X206',
*'X207','X208','X209','X210','X211','X212','X213','X214','X215',
*'X216','X217','X218','X219','X220','X221','X222','X223','X224',
*'X225','X226','X227','X228','X229','X230','X231','X232','X233',
*'X234','X235','X236','X237','X238','X239','X240','X241','X242',
*'X243','X244','X245','X246','X247','X248','X249','X250','X251',
*'X252','X253','X254','X255','X256','X257','X258','X259','X260',
*'X261','X262','X263','X264','X265','X266','X267','X268','X269',
*'X270','X271','X272','X273','X274','X275','X276','X277','X278',
*'X279','X280','X281','X282','X283','X284','X285','X286','X287',
*'X288','X289','X290','X291','X292','X293','X294','X295','X296',
*'X297','X298','X299','X300'/
 DATA COLN3/'X301','X302','X303','X304','X305',
*'X306','X307','X308','X309','X310','X311','X312','X313','X314',
*'X315','X316','X317','X318','X319','X320','X321','X322','X323',
*'X324','X325','X326','X327','X328','X329','X330','X331','X332',
*'X333','X334','X335','X336','X337','X338','X339','X340','X341',
*'X342','X343','X344','X345','X346','X347','X348','X349','X350',
*'X351','X352','X353','X354','X355','X356','X357','X358','X359',
*'X360','X361','X362','X363','X364','X365','X366','X367','X368',
*'X369','X370','X371','X372','X373','X374','X375','X376','X377',
*'X378','X379','X380','X381','X382','X383','X384','X385','X386',
*'X387','X388','X389','X390','X391','X392','X393','X394','X395',
*'X396','X397','X398','X399','X400','X401','X402','X403','X404',
*'X405','X406','X407','X408','X409','X410','X411','X412','X413',
*'X414','X415','X416','X417','X418','X419','X420','X421','X422',
*'X423','X424','X425','X426','X427','X428','X429','X430','X431',
*'X432','X433','X434','X435','X436','X437','X438','X439','X440',
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*'X441','X442','X443','X444','X445','X446','X447','X448','X449',
*'X450'/
 DATA COLN4/'X451','X452','X453','X454','X455','X456','X457','X458'
*,'X459','X460','X461','X462','X463','X464','X465','X466','X467',
*'X468','X469','X470','X471','X472','X473','X474','X475','X476',
*'X477','X478','X479','X480','X481','X482','X483','X484','X485',
*'X486','X487','X488','X489','X490','X491','X492','X493','X494',
*'X495','X496','X497','X498','X499','X500','X501','X502','X503',
*'X504','X505','X506','X507','X508','X509','X510','X511','X512',
*'X513','X514','X515','X516','X517','X518','X519','X520','X521',
*'X522','X523','X524','X525','X526','X527','X528','X529','X530',
*'X531','X532','X533','X534','X535','X536','X537','X538','X539',
*'X540','X541','X542','X543','X544','X545','X546','X547','X548',
*'X549','X550','X551','X552','X553','X554','X555','X556','X557',
*'X558','X559','X560','X561','X562','X563','X564','X565','X566',
*'X567','X568','X569','X570','X571','X572','X573','X574','X575',
*'X576','X577','X578','X579','X580','X581','X582','X583','X584',
*'X585','X586','X587','X588','X589','X590','X591','X592','X593',
*'X594','X595','X596','X597','X598','X599','X600'/
 DATA COLN5/'X601','X602',
*'X603','X604','X605','X606','X607','X608','X609','X610','X611',
*'X612','X613','X614','X615','X616','X617','X618','X619','X620',
*'X621','X622','X623','X624','X625','X626','X627','X628','X629',
*'X630','X631','X632','X633','X634','X635','X636','X637','X638',
*'X639','X640','X641','X642','X643','X644','X645','X646','X647',
*'X648','X649','X650','X651','X652','X653','X654','X655','X656',
*'X657','X658','X659','X660','X661','X662','X663','X664','X665',
*'X666','X667','X668','X669','X670','X671','X672','X673','X674',
*'X675','X676','X677','X678','X679','X680','X681','X682','X683',
*'X684','X685','X686','X687','X688','X689','X690','X691','X692',
*'X693','X694','X695','X696','X697','X698','X699','X700','X701',
*'X702','X703','X704','X705','X706','X707','X708','X709','X710',
*'X711','X712','X713','X714','X715','X716','X717','X718','X719',
$'X720','X721','X722','X723','X724','X725','X726','X727','X728',
*'X729','X730','X731','X732','X733','X734','X735','X736','X737',
*'X738','X739','X740','X741','X742','X743','X744','X745','X746',
*'X747','X748','X749','X750'/
 DATA COLN6/'X751','X752','X753','X754','X755',
*'X756','X757','X758','X759','X760','X761','X762','X763','X764',
*'X765','X766','X767','X768','X769','X770','X771','X772','X773',
*'X774','X775','X776','X777','X778','X779','X780','X781','X782',
*'X783','X784','X785','X786','X787','X788','X789','X790','X791',
*'X792','X793','X794','X795','X796','X797','X798','X799','X800',
*'X801','X802','X803','X804','X805','X806','X807','X808','X809',
*'X810','X811','X812','X813','X814','X815','X816','X817','X818',
*'X819','X820','X821','X822','X823','X824','X825','X826','X827',
*'X828','X829','X830','X831','X832','X833','X834','X835','X836',
*'X837','X838','X839','X840','X841','X842','X843','X844','X845',
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     *'X846','X847','X848','X849','X850','X851','X852','X853','X854',
     *'X855','X856','X857','X858','X859','X860','X861','X862','X863',
     *'X864','X865','X866','X867','X868','X869','X870','X871','X872',
     *'X873','X874','X875','X876','X877','X878','X879','X880','X881',
     *'X882','X883','X884','X885','X886','X887','X888','X889','X890',
     *'X891','X892','X893','X894','X895','X896','X897','X898','X899',
     *'X900'/
      DATA COLN7/'X901','X902','X903','X904','X905','X906','X907','X908'
     *,'X909','X910','X911','X912','X913','X914','X915','X916','X917',
     *'X918','X919','X920','X921','X922','X923','X924','X925','X926',
     *'X927','X928','X929','X930','X931','X932','X933','X934','X935',
     *'X936','X937','X938','X939','X940','X941','X942','X943','X944',
     *'X945','X946','X947','X948','X949','X950'/
      EQUIVALENCE (COLNAM(1),COLN1(1)),(COLNAM(151),COLN2(1)),
     *(COLNAM(301),COLN3(1)),(COLNAM(451),COLN4(1)),(COLNAM(601),COLN5(1
     *)),(COLNAM(751),COLN6(1)),(COLNAM(901),COLN7(1))
C
C        PART 4
C
      CCNSTR(1) = 1
      CCNSTR(2) = 4
      DC 5 I=1,5
      YEAR(I)=I
5     CONTINUE
      DO 9 J=1,865
      IHELP(J)=0
9     CONTINUE
      DO 2 I=1,36
      READ(5,136) SDTYPE(I),MAXFLH(I),CCNAME(I),RMMY(I)
136   FORMAT(A4,6X,I3,7X,A2,8X,F4.2)
2     CONTINUE
      DO 22 I=1,61
      READ(5,137) IMPNAM(I),(IMP(I,K),K=1,4)
137   FORMAT(A4,6X,4(I4,6X))
22    CONTINUE
      READ(5,138) (IMPTOP(I),I=1,4)
138   FORMAT(4(I5,5X))
      GARB=0
      DO 23 J=1,61
      ICOUNT(J)=0
23    CONTINUE
      N=0
C
C        PART 5
C
1     READ(3,END=500) ID,RELIMP,CC,CIV,MIL,CON,ACTYPE,HOURS3,COST4,COST5
      N=N+1
11    READ(2,200,END=500) JOB,KSTART,KEND,BENEF
```

```
200    FORMAT(I6,2(5X,I5),5X,F10.8)
12     IF (ID.NE.JOB) GO TO 450
       IF(KSTART.EQ.0) GO TO 1
       IHELP(N)=ID
       COLUMN(1)=BENEF
       DO 50 I=2,416
       COLUMN(I)=0.0
50     CONTINUE
C
C         PART 6
C
       DO 300 L=1,19
       IF(CC(L).EQ.DIGIT(1)) GO TO 300
       IF(L.LE.4) GO TO 150
       DO 140 K=KSTART,KEND
       INDEX1=17+L+35*(K-1)
       INDEM1=192+L+35*(K-1)
       INDEX2=1+K
       COLUMN(INDEX1)=CIV(INDEX2,L)
       COLUMN(INDEM1)=MIL(INDEX2,L)
140    CONTINUE
       GO TO 300
150    DO 270 K=KSTART,KEND
       IF(CC(L).EQ.DIGIT(6)) GO TO 240
       IF(CC(L).EQ.DIGIT(5)) GO TO 230
       IF(CC(L).EQ.DIGIT(4)) GO TO 220
       IF(CC(L).EQ.DIGIT(3)) GO TO 210
       IF(CC(L).NE.DIGIT(2)) GO TO 260
       INDEX1=2+5*(L-1)+35*(K-1)
       INDEM1=177+5*(L-1)+35*(K-1)
       GO TO 250
210    INDEX1=3+5*(L-1)+35*(K-1)
       INDEM1=178+5*(L-1)+35*(K-1)
       GO TO 250
220    INDEX1=4+5*(L-1)+35*(K-1)
       INDEM1=179+5*(L-1)+35*(K-1)
       GO TO 250
230    INDEX1=5+5*(L-1)+35*(K-1)
       INDEM1=180+5*(L-1)+35*(K-1)
       GO TO 250
240    INDEX1=6+5*(L-1)+35*(K-1)
       INDEM1=181+5*(L-1)+35*(K-1)
250    INDEX2=1+K
       COLUMN(INDEX1)=CIV(INDEX2,L)
       COLUMN(INDEM1)=MIL(INDEX2,L)
       GO TO 270
260    WRITE(6,265) ID,L,CC
265    FORMAT(10X,25HERROR IN COST CENTER CODE 5X,5HID = ,I6,5X,4HL = ,
```

```
     *I2,5X,5HCC = ,A2)
270   CONTINUE
300   CCNTINUE
C
C        PART 7
C
      DC 4 J=1,36
      DO 3 K=1,5
      FLHSUM(J,K)=0.
3     CCNTINUE
4     CONTINUE
C
C        PART 8
C
      CC 14 L=1,4
      DO 10 K=KSTART,KEND
      K1=K+1
      IF(ACTYPE(K1,L).EC.BLANK) GO TO 1C
      DO 8 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP1(J)) GO TO 17
8     CCNTINUE
      GO TO 18
17    FLHSUM(1,K)=FLHSUM(1,K)+HOURS3(K1,L)
      GC TO 10
18    DC 19 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP2(J)) GO TO 21
19    CCNTINUE
      GO TO 28
21    FLHSUM(2,K)=FLHSUM(2,K)+HOURS3(K1,L)
      GC TO 10
28    DO 29 J=1,7
      IF(ACTYPE(K1,L).EC.VTYP3(J)) GO TO 31
29    CONTINUE
      GC TO 32
31    FLHSUM(3,K)=FLHSUM(3,K)+HOURS3(K1,L)
      GO TO 10
32    CC 33 J=1,7
      IF(ACTYPE(K1,L).EC.VTYP4(J)) GO TC 34
33    CONTINUE
      GC TO 35
34    FLHSUM(4,K)=FLHSUM(4,K)+HOURS3(K1,L)
      GC TO 10
35    CO 36 J=1,7
      IF(ACTYPE(K1,L).EC.VTYP5(J)) GO TC 37
36    CONTINUE
      GO TO 38
37    FLHSUM(5,K)=FLHSUM(5,K)+HOURS3(K1,L)
      GC TO 10
```

```
38    DO 39 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP6(J)) GO TO 40
39    CONTINUE
      GO TO 41
40    FLHSUM(6,K)=FLHSUM(6,K)+HOURS3(K1,L)
      GO TO 10
41    DO 42 J=1,5
      IF(ACTYPE(K1,L).EQ.VTYP7(J)) GO TO 43
42    CONTINUE
      GO TO 44
43    FLHSUM(7,K)=FLHSUM(7,K)+HOURS3(K1,L)
      GO TO 10
44    IF(ACTYPE(K1,L).EQ.VTYP8) GO TO 46
      GO TO 47
46    FLHSUM(8,K)=FLHSUM(8,K)+HOURS3(K1,L)
      GO TO 10
47    DO 48 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP9(J)) GO TO 49
48    CONTINUE
      GO TO 51
49    FLHSUM(9,K)=FLHSUM(9,K)+HOURS3(K1,L)
      GO TO 10
51    DO 52 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP10(J)) GO TO 53
52    CONTINUE
      GO TO 54
53    FLHSUM(10,K)=FLHSUM(10,K)+HOURS3(K1,L)
      GO TO 10
54    DO 55 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP11(J)) GO TO 56
55    CONTINUE
      GO TO 57
56    FLHSUM(11,K)=FLHSUM(11,K)+HOURS3(K1,L)
      GO TO 10
57    DO 58 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP12(J)) GO TO 59
58    CONTINUE
      GO TO 60
59    FLHSUM(12,K)=FLHSUM(12,K)+HOURS3(K1,L)
      GO TO 10
60    DO 61 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP13(J)) GO TO 62
61    CONTINUE
      GO TO 63
62    FLHSUM(13,K)=FLHSUM(13,K)+HOURS3(K1,L)
      GO TO 10
63    DO 64 J=1,7
      IF(ACTYPE(K1,L).EQ.VTYP14(J)) GO TO 65
```

```
64    CONTINUE
      GO TO 66
65    FLHSUM(14,K)=FLHSUM(14,K)+HOURS3(K1,L)
      GO TO 10
66    DO 67 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP15(J)) GO TO 68
67    CONTINUE
      GO TO 69
68    FLHSUM(15,K)=FLHSUM(15,K)+HOURS3(K1,L)
      GO TO 10
69    IF(ACTYPE(K1,L).EQ.VTYP16)     GO TO 71
      GO TO 72
71    FLHSUM(16,K)=FLHSUM(16,K)+HOURS3(K1,L)
      GO TO 10
72    DO 73 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP17(J)) GO TO 74
73    CONTINUE
      GO TO 75
74    FLHSUM(17,K)=FLHSUM(17,K)+HOURS3(K1,L)
      GO TO 10
75    IF(ACTYPE(K1,L).EQ.VTYP18) GO TO 77
      GO TO 78
77    FLHSUM(18,K)=FLHSUM(18,K)+HOURS3(K1,L)
      GO TO 10
78    DO 79 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP19(J)) GO TO 80
79    CONTINUE
      GO TO 81
80    FLHSUM(19,K)=FLHSUM(19,K)+HOURS3(K1,L)
      GO TO 10
81    IF(ACTYPE(K1,L).EQ.VTYP20) GO TO 83
      GO TO 84
83    FLHSUM(20,K)=FLHSUM(20,K)+HOURS3(K1,L)
      GO TO 10
84    IF(ACTYPE(K1,L).EQ.VTYP21) GO TO 86
      GO TO 87
86    FLHSUM(21,K)=FLHSUM(21,K)+HOURS3(K1,L)
      GO TO 10
87    DO 88 J=1,5
      IF(ACTYPE(K1,L).EQ.VTYP22(J)) GO TO 89
88    CONTINUE
      GO TO 90
89    FLHSUM(22,K)=FLHSUM(22,K)+HOURS3(K1,L)
      GO TO 10
90    DO 91 J=1,9
      IF(ACTYPE(K1,L).EQ.VTYP23(J)) GO TO 92
91    CONTINUE
      GO TO 93
```

```
92    FLHSUM(23,K)=FLHSUM(23,K)+HOURS3(K1,L)
      GO TO 10
93    DO 94 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP24(J)) GO TO 95
94    CONTINUE
      GO TO 96
95    FLHSUM(24,K)=FLHSUM(24,K)+HOURS3(K1,L)
      GO TO 10
96    DO 97 J=1,3
      IF(ACTYPE(K1,L).EQ.VTYP25(J)) GO TO 98
97    CONTINUE
      GO TO 99
98    FLHSUM(25,K)=FLHSUM(25,K)+HOURS3(K1,L)
      GO TO 10
99    IF(ACTYPE(K1,L).EQ.VTYP26) GO TO 101
      GO TO 102
101   FLHSUM(26,K)=FLHSUM(26,K)+HOURS3(K1,L)
      GO TO 10
102   IF(ACTYPE(K1,L).EQ.VTYP27) GO TO 104
      GO TO 105
104   FLHSUM(27,K)=FLHSUM(27,K)+HOURS3(K1,L)
      GO TO 10
105   IF(ACTYPE(K1,L).EQ.VTYP28)     GO TO 107
      GO TO 108
107   FLHSUM(28,K)=FLHSUM(28,K)+HOURS3(K1,L)
      GO TO 10
108   DO 109 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP29(J)) GO TO 111
109   CONTINUE
      GO TO 112
111   FLHSUM(29,K)=FLHSUM(29,K)+HOURS3(K1,L)
      GO TO 10
112   DO 113 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP30(J)) GO TO 114
113   CONTINUE
      GO TO 115
114   FLHSUM(30,K)=FLHSUM(30,K)+HOURS3(K1,L)
      GO TO 10
115   IF(ACTYPE(K1,L).EQ.VTYP31)     GO TO 117
      GO TO 118
117   FLHSUM(31,K)=FLHSUM(31,K)+HOURS3(K1,L)
      GO TO 10
118   DO 119 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP32(J)) GO TO 121
119   CONTINUE
      GO TO 122
121   FLHSUM(32,K)=FLHSUM(32,K)+HOURS3(K1,L)
      GO TO 10
```

```
122   IF(ACTYPE(K1,L).EQ.VTYP33)     GC TC 124
      GC TO 125
124   FLHSUM(33,K)=FLHSUM(33,K)+HCURS3(K1,L)
      GC TO 10
125   DC 126 J=1,4
      IF(ACTYPE(K1,L).EQ.VTYP34(J)) GC TC 127
126   CONTINUE
      GC TO 128
127   FLHSUM(34,K)=FLHSUM(34,K)+HOURS3(K1,L)
      GC TO 10
128   DC 129 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP35(J)) GC TC 130
129   CONTINUE
      GO TO 131
130   FLHSUM(35,K)=FLHSUM(35,K)+HOURS3(K1,L)
      GC TO 10
131   DC 132 J=1,2
      IF(ACTYPE(K1,L).EQ.VTYP36(J)) GO TO 133
132   CCNTINUE
      GO TO 134
133   FLHSUM(36,K)=FLHSUM(36,K)+HOURS3(K1,L)
      GO TO 10
134   WRITE(6,135) ACTYPE(K1,L),HOURS3(K1,L),ID,K
135   FCRMAT(1H ,24HUNKNCWN AIRCRAFT TYPE : ,A4,5X,14HFLIGT HOURS : ,F5.
     *0,5X,5HID = ,I6,5X,12HPLAN.YEAR = ,I1)
      GARB=GARB+HOURS3(K1,L)
10    CONTINUE
C
C        PART 9
C
      IF(RELIMP(L).EQ.BLANK) GO TC 14
      DO 139 J=1,61
      IF(RELIMP(L).EQ.IMPNAM(J)) GO TO 161
139   CONTINUE
      IF(RELIMP(L).EQ.EXTRA(1)) GO TO 142
      IF(RELIMP(L).EQ.EXTRA(2)) GO TO 143
      IF(RELIMP(L).EQ.EXTRA(3)) GO TO 144
      IF(RELIMP(L).EQ.EXTRA(4)) GO TO 145
      IF(RELIMP(L).EQ.EXTRA(5)) GO TO 146
      IF(RELIMP(L).EQ.EXTRA(6)) GO TO 147
      IF(RELIMP(L).EQ.EXTRA(7)) GO TO 148
      IF(RELIMP(L).EQ.EXTRA(8)) GO TO 149
      IF(RELIMP(L).EQ.EXTRA(9)) GO TO 151
      IF(RELIMP(L).EQ.EXTRA(10)) GO TO 152
      IF(RELIMP(L).EQ.EXTRA(11)) GO TC 153
      WRITE(6,154) ID,RELIMP(L)
154   FORMAT(1H ,10X,5HID = ,I6,5X,14HUNKNOWN IMP : ,A4)
      GO TO 14
```

```
142   J=1
      GO TO 161
143   J=17
      GO TO 161
144   J=22
      GO TO 161
145   J=27
      GO TO 161
146   J=30
      GO TO 161
147   J=27
      GO TO 161
148   J=38
      GO TO 161
149   J=46
      GO TO 161
151   J=48
      GO TO 161
152   J=51
      GO TO 161
153   J=54
161   INDEX3=351+J
      COLUMN(INDEX3)=1.0
      ICOUNT(J)=ICOUNT(J)+1
14    CONTINUE
C
C        PART 10
C
      DO 360 K=KSTART,KEND
      TOTAL1=0.
      TOTAL2=0.
      TOTAL3=0.
      TOTAL4=0.
      DO 350 J=1,36
      IF(FLHSUM(J,K).EQ.0.) GO TO 350
      MMY(J,K)=FLHSUM(J,K)*RMMY(J)/100.
      IF(CCNAME(J).EQ.DIGIT(4)) GO TO 341
      IF(CCNAME(J).EQ.DIGIT(2)) GO TO 342
      IF(CCNAME(J).EQ.DIGIT(3)) GO TO 343
      IF(CCNAME(J).NE.DIGIT(6)) GO TO 344
      TOTAL4=TOTAL4+MMY(J,K)
      GO TO 350
341   TOTAL3=TOTAL3+MMY(J,K)
      GO TO 350
342   TOTAL1=TOTAL1+MMY(J,K)
      GO TO 350
343   TOTAL2=TOTAL2+MMY(J,K)
      GO TO 350
```

```
344   WRITE(6,345) ID,J,SDTYPE(J),CCNAME(J)
345   FORMAT(1H ,23HERROR IN CCNAME : ID = ,I6,5X,4HJ = ,I2,9HSDTYPE = ,
     *A4,5X,9HCCNAME = ,A2)
350   CONTINUE
      INDEX4=192+35*(K-1)
      INDEX5=193+35*(K-1)
      INDEX6=194+35*(K-1)
      INDEX7=196+35*(K-1)
      IF(TOTAL1.GT.COLUMN(INDEX4)) COLUMN(INDEX4)=TOTAL1
      IF(TOTAL2.GT.COLUMN(INDEX5)) COLUMN(INDEX5)=TOTAL2
      IF(TOTAL3.GT.COLUMN(INDEX6)) COLUMN(INDEX6)=TOTAL3
      IF(TOTAL4.GT.COLUMN(INDEX7)) COLUMN(INDEX7)=TOTAL4
360   CONTINUE
C
C        PART 11
C
      IF(N.GT.1) GO TO 415
      WRITE(10,400) NAM,JOBN
400   FORMAT(A4,10X,2A4)
      WRITE(6,600)  NAM,JOBN
600   FORMAT(1H ,A4,10X,2A4)
      WRITE(10,701) RCARD
701   FORMAT(A4)
      WRITE(6,601) RCARD
601   FORMAT(1H ,A4)
      WRITE(10,702)  TYPE1,OBFNAM
      WRITE(6,602)   TYPE1,OBFNAM
702   FORMAT(3A4)
602   FORMAT(1H ,A4,2A4)
C
C        PART 12
C
      DO 412 L=1,2
      DO 410 K=1,5
      DO 405 I=1,35
      WRITE(10,712) TYPE2,ROWGN1(L),CONSTR(1),FACC(I),YEAR(K)
      WRITE( 6,612) TYPE2,ROWGN1(L),CONSTR(1),FACC(I),YEAR(K)
712   FORMAT(A4,2(A2,I1))
612   FORMAT(1H ,A4,2(A2,I1))
405   CONTINUE
410   CONTINUE
412   CONTINUE
C
C        PART 13
C
      DO 515 L=1,65
      IF(L.GT.9) GO TO 413
      WRITE(10,714) TYPE2,ROWIMP,FACC(L)
```

```
      WRITE(6,614) TYPE2,ROWIMP,FACC(L)
714   FORMAT(2A4,A2)
614   FORMAT(1H ,2A4,A2)
      GO TO 515
413   WRITE(10,715) TYPE2,ROWIMP,L
      WRITE(6,615) TYPE2,ROWIMP,L
715   FORMAT(2A4,I2)
615   FORMAT(1H ,2A4,I2)
515   CONTINUE
C
C        PART 14
C
      DO 525 L=1,2
      DO 524 K=1,5
      DO 523 I=1,35
      WRITE(10,712) TYPE2,ROWGN1(L),CONSTR(2),FACC(I),YEAR(K)
      WRITE(6,612) TYPE2,ROWGN1(L),CONSTR(2),FACC(I),YEAR(K)
523   CONTINUE
524   CONTINUE
525   CONTINUE
      WRITE(10,702) COLMNS
      WRITE(6,610) COLMNS
610   FORMAT(1H ,2A4)
      WRITE(10,711) MARK
      WRITE(6,611) MARK
611   FORMAT(1H ,4X,5HNAME1,5X,2A4,2X,7HINTEGER)
711   FORMAT(4X,5HNAME1,5X,2A4,2X,7HINTEGER)
415   WRITE(10,703) COLNAM(ID),OBFNAM,COLUMN(1)
703   FORMAT(4X,A4,6X,2A4,2X,F12.8)
      WRITE(6,603) COLNAM(ID),OBFNAM,COLUMN(1)
603   FORMAT(1H ,4X,A4,6X,2A4,2X,F12.8)
C
C        PART 15
C
      DO 420 L=1,2
      DO 418 K=1,5
      DO 416 I=1,35
      INDEX=175*(L-1)+35*(K-1)+I+1
      IF(COLUMN(INDEX).EQ.0.) GO TO 416
      WRITE(10,704) COLNAM(ID),ROWGN1(L),CONSTR(1),FACC(I),YEAR(K),
     *COLUMN(INDEX)
      WRITE( 6,604) COLNAM(ID),ROWGN1(L),CONSTR(1),FACC(I),YEAR(K),
     *COLUMN(INDEX)
604   FORMAT(1H ,4X,A4,6X,2(A2,I1),4X,F8.4)
704   FORMAT(4X,A4,6X,2(A2,I1),4X,F8.4)
416   CONTINUE
418   CONTINUE
420   CONTINUE
```

```
C
C          PART 16
C
      DO 425 L=1,61
      INDEX=351+L
      IF(COLUMN(INDEX).EQ.0.) GO TO 425
      IF(L.GT.9) GO TO 421
      WRITE(10,724) COLNAM(ID),ROWIMP,FACC(L),COLUMN(INDEX)
      WRITE(6,624) COLNAM(ID),ROWIMP,FACC(L),COLUMN(INDEX)
724   FORMAT(4X,A4,6X,A4,A2,4X,F8.4)
624   FORMAT(1H ,4X,A4,6X,A4,A2,4X,F8.4)
      GO TO 425
421   WRITE(10,726) COLNAM(ID),ROWIMP,L,COLUMN(INDEX)
      WRITE(6,626) COLNAM(ID),ROWIMP,L,COLUMN(INDEX)
626   FORMAT(1H ,4X,A4,6X,A4,I2,4X,F8.4)
726   FORMAT(4X,A4,6X,A4,I2,4X,F8.4)
425   CONTINUE
      GO TO 1
C
C          PART 17
C
450   WRITE(6,606) ID,JOB
606   FORMAT(10X,46HID OF PRIO AND MASTER DO NOT MATCH : MASTER = ,I6,5X
     *,7HPRIO = ,I6)
      IF(ID.GT.JOB) GO TO 11
      DO 15 I=1,20
      IF(I.GT.1) GO TO 25
      WRITE(6,110) ID
110   FORMAT(10X,I6//)
25    WRITE(6,120) CC(I),(CIV(M,I),M=2,6)
120   FORMAT(10X,A2,5(F5.1,5X))
15    CONTINUE
      READ(3,END=500) ID,RELIMP,CC,CIV,MIL,CON,ACTYPE,HOURS3,COST4,COST5
      GO TO 12
500   CONTINUE
C
C          PART 18
C
      DO 770 J=1,61
      IF(ICOUNT(J).EQ.0) GO TO 770
      DO 735 I=352,416
      COLUMN(I)=0.0
735   CONTINUE
      INDEX=351+J
      COLUMN(INDEX)=-ICOUNT(J)
      DO 740 I=1,4
      INDEX=412+I
      COLUMN(INDEX)=IMP(J,I)
```

```
740    CONTINUE
       DO 765 I=352,416
       IF(COLUMN(I).EQ.0.) GO TO 765
       L=I-351
       IF(J.GT.9) GO TO 744
       IF(L.GT.9) GO TO 742
       WRITE(10,741) IMPVN,FACC(J),ROWIMP,FACC(L),COLUMN(I)
       WRITE( 6,641) IMPVN,FACC(J),ROWIMP,FACC(L),COLUMN(I)
741    FORMAT(    4X,A4,A2,4X,A4,A2,4X,F7.1)
641    FORMAT(1H ,4X,A4,A2,4X,A4,A2,4X,F7.1)
       GO TO 765
742    WRITE(10,743) IMPVN,FACC(J),ROWIMP,L,COLUMN(I)
       WRITE( 6,643) IMPVN,FACC(J),ROWIMP,L,COLUMN(I)
743    FORMAT(    4X,A4,A2,4X,A4,I2,4X,F7.1)
643    FORMAT(1H ,4X,A4,A2,4X,A4,I2,4X,F7.1)
       GO TO 765
744    IF(L.GT.9) GO TO 746
       WRITE(10,745) IMPVN,J,ROWIMP,FACC(L),COLUMN(I)
       WRITE(6,645) IMPVN,J,ROWIMP,FACC(L),COLUMN(I)
745    FORMAT(4X,A4,I2,4X,A4,A2,4X,F7.1)
645    FORMAT(1H ,4X,A4,I2,4X,A4,A2,4X,F7.1)
       GO TO 765
746    WRITE(10,747) IMPVN,J,ROWIMP,L,COLUMN(I)
747    FORMAT(4X,A4,I2,4X,A4,I2,4X,F7.1)
       WRITE(6,647) IMPVN,J,ROWIMP,L,COLUMN(I)
647    FORMAT(1H ,4X,A4,I2,4X,A4,I2,4X,F7.1)
765    CONTINUE
770    CONTINUE
       WRITE(10,771) MARK
       WRITE(6,671) MARK
671    FORMAT(1H ,4X,5HNAME2,5X,2A4,2X,7HINTEGER)
771    FORMAT(4X,5HNAME2,5X,2A4,2X,7HINTEGER)
C
C         PART 19
C
       DO 550 NA=1,19
       READ(5,530) (TREMA(M),M=1,19)
530    FORMAT(19(F3.1,1X))
       IF(NA.GT.4) GO TO 532
       FLAG=0.
       J=1+5*(NA-1)
       JM=J+4
       GO TO 533
532    I=NA+16
       FLAG=1.0
       GO TO 534
533    I=J-1
531    I=I+1
```

```
      IF(I.GT.JM) GO TO 550
534   DC 546 L=1,35
      IF(I.EQ.L) GO TO 535
      IF(L.GT.20) GO TO 544
      IF(L.GT.15) GO TO 542
      IF(L.GT.10) GO TO 540
      IF(L.GT.5) GO TO 538
      M=1
      GO TO 545
535   RECOST(I,L)=0.0
      GO TO 546
538   M=2
      GC TO 545
540   M=3
      GO TO 545
542   M=4
      GO TO 545
544   M=L-16
545   RECOST(I,L)=TREMA(M)
546   CONTINUE
      IF(FLAG.NE.0.0) GO TO 550
      GC TO 531
550   CONTINUE
      DC 552 I=1,35
      WRITE(6,551) (RECCST(I,L),L=1,20)
551   FCRMAT(10X,20(F3.1,2X))
552   CCNTINUE
      DO 554 I=1,35
      WRITE(6,553) (RECOST(I,L),L=21,35)
553   FCRMAT(10X,15(F3.1,2X))
554   CONTINUE
C
C         PART 20
C
      GAMMA=0.01
      DC 585 K=1,5
      DO 580 I=1,35
      CC 575 L=1,35
      IF(RECOST(I,L).EQ.9.0) GO TC 575
      DO 560 J=1,3
      CCLUMN(J)=0.0
560   CONTINUE
      IF(I.EQ.L) GO TO 562
      CCLUMN(1)=-GAMMA*RECOST(I,L)
      CCLUMN(2)=-1.0/(1.C+RECOST(I,L))
      GC TO 564
562   CCLUMN(2)=-1.0
564   CCLUMN(3)=1.0
```

```
      IF(COLUMN(1).EQ.0.) GO TO 568
      WRITE(10,565) VYNAM(1),FACC(I),FACC(L),YEAR(K),OBFNAM,COLUMN(1)
      WRITE(6,566) VYNAM(1),FACC(I),FACC(L),YEAR(K),OBFNAM,COLUMN(1)
565   FORMAT(4X,3A2,I1,3X,2A4,2X,F12.6)
566   FORMAT(1H ,4X,3A2,I1,3X,2A4,2X,F12.6)
568   WRITE(10,569) VYNAM(1),FACC(I),FACC(L),YEAR(K),ROWGN1(1),CONSTR(1)
     *,FACC(L),YEAR(K),COLUMN(2)
      WRITE(6,570) VYNAM(1),FACC(I),FACC(L),YEAR(K),ROWGN1(1),CONSTR(1),
     *FACC(L),YEAR(K),COLUMN(2)
      WRITE(10,569) VYNAM(1),FACC(I),FACC(L),YEAR(K),ROWGN1(1),CONSTR(2)
     *,FACC(I),YEAR(K),COLUMN(3)
      WRITE(6,570) VYNAM(1),FACC(I),FACC(L),YEAR(K),ROWGN1(1),CONSTR(2)
     *,FACC(I),YEAR(K),COLUMN(3)
569   FORMAT(4X,3A2,I1,3X,2(A2,I1),4X,F12.6)
570   FORMAT(1H ,4X,3A2,I1,3X,2(A2,I1),4X,F12.6)
575   CONTINUE
580   CONTINUE
585   CONTINUE
C
C         PART 21
C
      DO 598 K=1,5
      DO 596 I=1,35
      DO 594 L=1,35
      DO 588 J=1,3
      COLUMN(J)=0.0
588   CONTINUE
      IF(I.EQ.L) GO TO 590
      COLUMN(1)=-GAMMA
590   COLUMN(2)=-1.0
      COLUMN(3)=1.0
      IF(COLUMN(1).EQ.0.) GO TO 591
      WRITE(10,565) VYNAM(2),FACC(I),FACC(L),YEAR(K),OBFNAM,COLUMN(1)
      WRITE(6,566) VYNAM(2),FACC(I),FACC(L),YEAR(K),OBFNAM,COLUMN(1)
591   WRITE(10,569) VYNAM(2),FACC(I),FACC(L),YEAR(K),ROWGN1(2),CONSTR(1)
     *,FACC(L),YEAR(K),COLUMN(2)
      WRITE(6,570) VYNAM(2),FACC(I),FACC(L),YEAR(K),ROWGN1(2),CONSTR(1)
     *,FACC(L),YEAR(K),COLUMN(2)
      WRITE(10,569) VYNAM(2),FACC(I),FACC(L),YEAR(K),ROWGN1(2),CONSTR(2)
     *,FACC(I),YEAR(K),COLUMN(3)
      WRITE(6,570) VYNAM(2),FACC(I),FACC(L),YEAR(K),ROWGN1(2),CONSTR(2)
     *,FACC(I),YEAR(K),COLUMN(3)
594   CONTINUE
596   CONTINUE
598   CONTINUE
C
C         PART 22
C
```

```
      WRITE(10,701) RHSCAR
      WRITE(6,605)  RHSCAR
605   FORMAT(1H ,A4)
      DO 700 L=1,35
      READ(5,607)  (TEMP(I),I=1,5)
607   FORMAT(10X,5F10.1)
      DO 650 K=1,5
      INDEX=415+L+35*(K-1)
      RHSN(INDEX)=TEMP(K)
650   CONTINUE
700   CONTINUE
C
C        PART 23
C
      DO 750 L=1,35
      READ(5,607) (TEMP(I),I=1,5)
      DO 720 K=1,5
      INDEX8=590+L+35*(K-1)
      RHSN(INDEX8)=TEMP(K)
720   CONTINUE
750   CONTINUE
      DO 760 J=1,411
      RHSN(J)=0.
760   CONTINUE
      DO 775 J=1,4
      RHSN(411+J)=IMPTOP(J)
775   CONTINUE
      INDEX=0
C
C        PART 24
C
      DO 800 L=1,2
      DO 790 K=1,5
      DO 780 I=1,35
      INDEX=INDEX+1
      WRITE(10,704) RHSNAM,ROWGN1(L),CONSTR(1),FACC(I),YEAR(K),
     *RHSN(INDEX)
      WRITE( 6,604) RHSNAM,ROWGN1(L),CONSTR(1),FACC(I),YEAR(K),
     *RHSN(INDEX)
780   CONTINUE
790   CONTINUE
800   CONTINUE
C
C        PART 25
C
      DO 850  L=1,65
      INDEX=INDEX+1
      IF(L.GT.9) GO TO 840
```

```
      WRITE(10,724) RHSNAM,ROWIMP,FACC(L),RHSN(INDEX)
      WRITE( 6,624) RHSNAM,ROWIMP,FACC(L),RHSN(INDEX)
      GO TO 850
840   WRITE(10,791) RHSNAM,ROWIMP,L,RHSN(INDEX)
      WRITE( 6,691) RHSNAM,ROWIMP,L,RHSN(INDEX)
691   FORMAT(1H ,4X,A4,6X,A4,I2,4X,F7.1)
791   FORMAT(4X,A4,6X,A4,I2,4X,F7.1)
850   CONTINUE
C
C         PART 26
C
      INDEX=415
      DO 880 L=1,2
      DO 870 K=1,5
      DO 860 I=1,35
      INDEX=INDEX+1
      WRITE(10,704) RHSNAM,ROWGN1(L),CONSTR(2),FACC(I),YEAR(K),
     *RHSN(INDEX)
      WRITE( 6,604) RHSNAM,ROWGN1(L),CONSTR(2),FACC(I),YEAR(K),
     *RHSN(INDEX)
860   CONTINUE
870   CONTINUE
880   CONTINUE
C
C         PART 27
C
      WRITE(10,702) BOUND
      WRITE(6,610) BOUND
      UPBND=1.0
      DO 900 I=1,N
      IF(IHELP(I).EQ.0) GO TO 900
      WRITE(10,709) UPWORD,BOUNAM,COLNAM(IHELP(I)),UPBND
709   FORMAT(2A4,6X,A4,6X,F5.1)
      WRITE(6,609) UPWORD,BOUNAM,COLNAM(IHELP(I)),UPBND
609   FORMAT(1H ,A4,A4,6X,A4,6X,F5.1)
900   CONTINUE
C
C         PART 28
C
      DO 950 J=1,61
      IF(ICOUNT(J).EQ.0) GO TO 950
      IF(J.GT.9) GO TO 930
      WRITE(10,911) UPWORD,BOUNAM,IMPVN,FACC(J),UPBND
      WRITE( 6,912) UPWORD,BOUNAM,IMPVN,FACC(J),UPBND
911   FORMAT(2A4,6X,A4,A2,4X,F5.1)
912   FORMAT(1H ,2A4,6X,A4,A2,4X,F5.1)
      GO TO 950
930   WRITE(10,913) UPWORD,BOUNAM,IMPVN,J,UPBND
```

```
      WRITE( 6,914) UPWCRD,BOUNAM,IMPVN,J,UPBND
913   FORMAT(2A4,6X,A4,I2,4X,F5.1)
914   FORMAT(1H ,2A4,6X,A4,I2,4X,F5.1)
950   CONTINUE
      WRITE(10,702) ENDAT
      WRITE(6,610) ENDAT
      END FILE 10
      WRITE(6,960) GARB
960   FORMAT(1H ,10X,10HGARBAGE = ,F5.0,5X,12HFLIFGT HOURS)
      STOP
      END
//GO.FT03F001 DD UNIT=3330,DISP=SHR,VOL=SER=DISK03,DSN=S1948.KRIS.DATA2
//GO.SYSIN DD *
A3          250        SA         1.29
A4          500        SA          .76
A6          350        SA         2.21
A7          300        SA         1.36
AV8         250        SA         2.03
..........................................
  A1        490        810        840        915
  A2       1076        500        500        500
  A3        265        600        490        600
  A4        500        550        150          0
  A5          0       1000        400       1800
..............................................................................
0.3 0.8 0.3 9.0 1.5 1.5 0.3 1.0 1.0 1.0 1.5 1.5 1.2 1.0 0.8 0.5 1.0 9.0 9.0
0.8 0.3 0.3 9.0 0.3 0.3 0.5 0.5 1.0 0.3 0.5 0.5 0.7 0.5 0.7 0.5 0.5 9.0 9.0
0.3 0.5 0.2 9.0 0.7 0.5 0.5 0.3 1.0 1.0 0.5 1.0 1.2 1.0 1.0 0.8 1.0 9.0 9.0
9.0 9.0 9.0 0.1 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 0.4 0.5 0.5 9.0 0.5 0.3 9.0
0.5 0.3 0.5 9.0 0.0 0.3 0.5 0.5 1.0 0.3 0.5 0.5 1.0 0.8 0.6 0.8 0.6 9.0 9.0
..............................................................................
  CL2AAT          8.         8.         9.         9.        10.
  CL2ARW         10.5       12.        12.        12.        12.
  CL2ASA         25.        25.        25.        25.        25.
  CL2ASY          0.         0.         0.         0.         0.
  CL2ATP          9.         9.        10.        10.        10.
..................................................................
                  7.         7.         7.         7.         7.
                  4.         4.         4.         4.         4.
                 10.        10.        10.        10.        10.
                  0.         0.         0.         0.         0.
                 14.        14.        14.        14.        14.
..................................................................
//GO.FT02F001 DD *
    1          1          5       0.99993718
    2          1          3       0.89108044
    3          1          5       0.45629483
    4          1          5       0.45483220
```

```
     5          1          5      0.7344C23C
.......................................................................
//GO.FT1CF001  DD  UNIT=3330,VOL=SER=DISK04,
//   DISP=(NEW,KEEP),DSN=S1948.DATARE,
//   SPACE=(TRK,300,RLSE),
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
```

LIST OF REFERENCES

1. Enthoven, Alain C., Analysis, Judgement and Computers, Business Horizons, August 1969.

2. Buffum, Robert S., Workforce Planning Models for the Naval Air Test Center, M.S. Thesis, Naval Postgraduate School, Monterey, 1978.

3. Etzioni, Amatai, Mixed Scanning: A "Third" Approach to Decision Making, Public Administration Review, December 1967.

4. Hillier, F.S. and Lieberman, G.J., Operations Research, Holden-Day, Inc., 2nd Edition.

5. Bureau of Policies and Standards, Planning Your Staffing Needs, United States Civil Service Commission, 1977.

6. Naval Air Test Center, Instruction Booklet, Workload Plan Management System.

7. IBM Publication, H20-0476-1, Mathematical Programming System/360 (360A-CO-14X) Linear and Separable Programming -- User's Manual.

8. Brown, G. and Graves, G., XS - An Experimental System for Very Large Scale Mixed Integer Optimization with Elastic Programming, National ORSA/TIMS Convention, Las Vegas, Nevada, Nov. 17, 1975.

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